FOOD FOR PLANTS

MYERS

FOOD FOR PLANTS

New Edition
With Supplementary Notes

EDITED AND PUBLISHED BY
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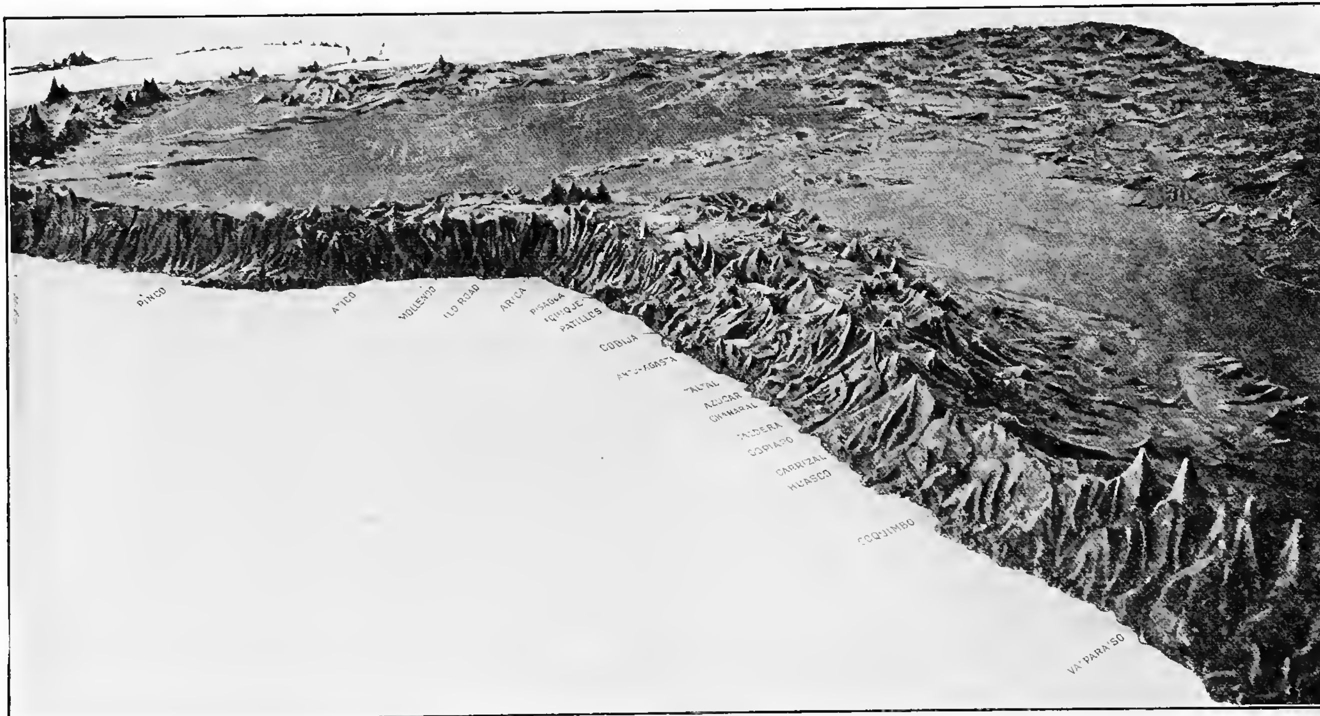


Section of Relief Map of South America.— Chile in right foreground.

PREFACE

This is the twelfth edition of Food for Plants and, after repeated and extended revisions, the work has come to have a standard place in our American farm literature. It nows includes results of original investigations and experiments on Highlands Experimental Farms, made under the personal direction of the late Professor E. B. Voorhees.

The main purpose of all the within recorded experiments has been to demonstrate the value of Nitrate of Soda in the scheme of rational fertilization on a practical scale. The investigations have covered more particularly the questions of amount of Nitrate and other chemicals to be employed, time of application for most profitable results and practical methods for the preparation of grass lands and the harvesting of the hay crop.

These recorded experiments set forth the field work intended as demonstrations in farm practice of what may be accomplished by the rational use of Nitrate of Soda under average farm conditions in a typical dairy section of New York State.

The earlier results have appeared from time to time in former editions of "Food for Plants," "Grass Growing for Profit," and "Growing Timothy Hay for Market"—all practical farm books of value, based on actual scientific and sound practical data. Studies having been made of methods of crop growing, from the preparation of the land to handling and marketing the crops, it is believed that these volumes have unique and unusual value.

WILLIAM S. MYERS.

Blasting a Test Hole.

Caliche Ready for Transport to Oficina.

FOOD FOR PLANTS

The Food of Plants consists of a number of elements, including Nitrate, phosphate, lime and potash. Nearly always two of these are lacking in adequate quantities to produce crops, especially is Nitrate wanting in the vast majority of instances. In this case the normal growth and yield of the crop will be limited only by the quantity of *Nitrate* it can properly assimilate. There might be an abundant supply of all the other elements, but plants can never use other kinds of food without Nitrate.

Why Nitrate Is Indispensable.

Nitrate Nitrogen is the food that is nearly always deficient. The question that presents itself to the farmer, gardener and fruit grower is, How can I supply my plants with Nitrogen, phosphoric acid and potash, in the best forms and at the least expense? We will try to throw some light upon this question in the following pages. We will take first, Phosphoric Acid.

Nitrate Nearly Always Deficient.

There are several sources of phosphoric acid, the principal being bones and rock phosphate. Of these, the rock phosphate is the cheapest source. A prevailing impression exists that superphosphate made from rock phosphate is not as good as that made from bones. It has been shown by many experiments that this idea is entirely without foundation. What the plants want is available phosphoric acid, and it makes little or no difference from what source it is derived.

Phosphoric Acid.

The largest deposits of rock phosphates exist in South Carolina, Florida and Tennessee. These beds of phosphate are supposed to be composed of the petrified bones and excrements of extinct animals. When this substance is ground and mixed with a sufficient quantity of sulphuric acid, the larger part of the phosphoric acid which it contains becomes available as plant food. This fact was one of the greatest agricultural discoveries of the age.

When the rock phosphate is thus treated with sulphuric acid, it becomes what is commercially known as superphosphate, or acid phosphate. The same is true if ground bone is treated in the same way. Good superphosphate, or acid phosphate, contains about 14 per cent. of soluble phosphoric acid.

Potashes. The best sources of potash are sulphate of potash and unleached wood ashes, which latter contain from 3 to 5 per cent. of potash in the form of carbonate. They also contain from 1 to 2½ per cent. of phosphoric acid. They are valuable as plant food for the potash as well as for the valuable lime they contain.

Nitrate. Nitrate is the most important and effective element of plant food, and at the same time, as stated, is the one that is generally deficient in the soil.

Crops must have meals, that is, food cooked for them in advance. The sun will help do this cooking, as its heat and light promote nitration which is really a process of cooking and also pre-digestion. When the nitrogenous plant food is cooked and prepared for use it is Nitrate, hence Nitrate of Soda is in a class by itself, different from all other plant foods.

There are a great many sources of Nitrogen, such as dried fish, cotton-seed meal, dried blood, and tankage. But none of these furnish Nitrogen in the Nitrate form in which it is taken up by plants. This can only be furnished to plants in the form of Nitrate of Soda. Nitro-

gen applied in any other form must be first converted into Nitrate before it can be used by plants at all.

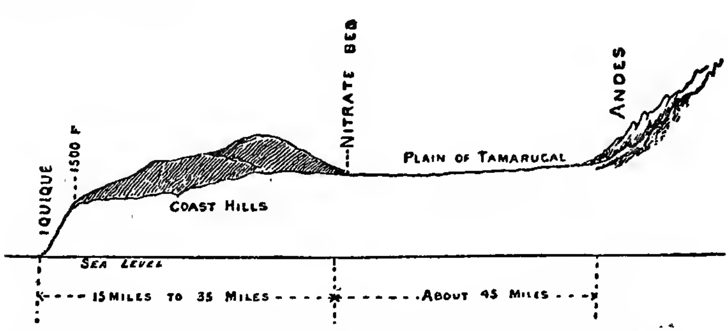
Nitrate of Soda contains the Nitrogen that is necessary for the growth of plants, and is the best form in which to furnish it to them. When we say the *best* form we mean as well the best *practical* form. Nitrate of Soda not only furnishes Nitrogen in its most available form, but it furnishes it cheaper than any other source, because 100 per cent. of it or all is available.

No other form containing so much available plant food is also capable of unlocking the latent potash in the soil.

Materials Used in Making Commercial or Chemical Fertilizers.

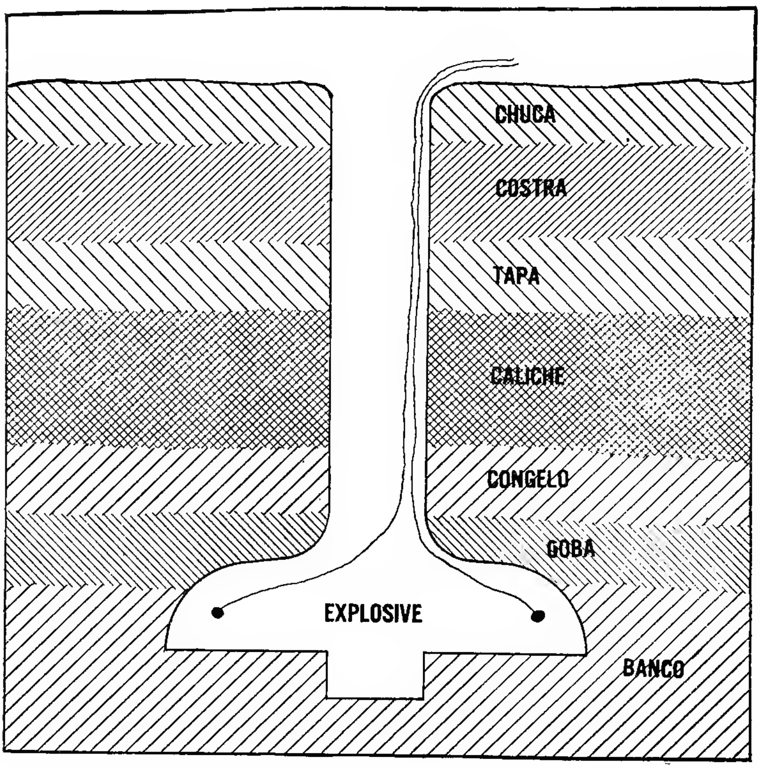
Nitrate of Soda or Chile Saltpetre.

Nitrate of Soda or Chile Saltpetre occurs in vast deposits in the rainless districts of the west coast of South America, chiefly in Chile, from whence it is imported to this country for use in chemical manufacture and in agriculture. As imported into the United States, Nitrate of Soda usually contains about 15 per cent. of Nitrogen. Nitrate of Soda resembles common salt, with which and sodium sulphate it is often adulterated. This salt is at once available as a direct fertilizer. Whenever practicable, it should be applied as a top-dressing to growing crops, and if possible the dressings should be given in two or three successive rations.



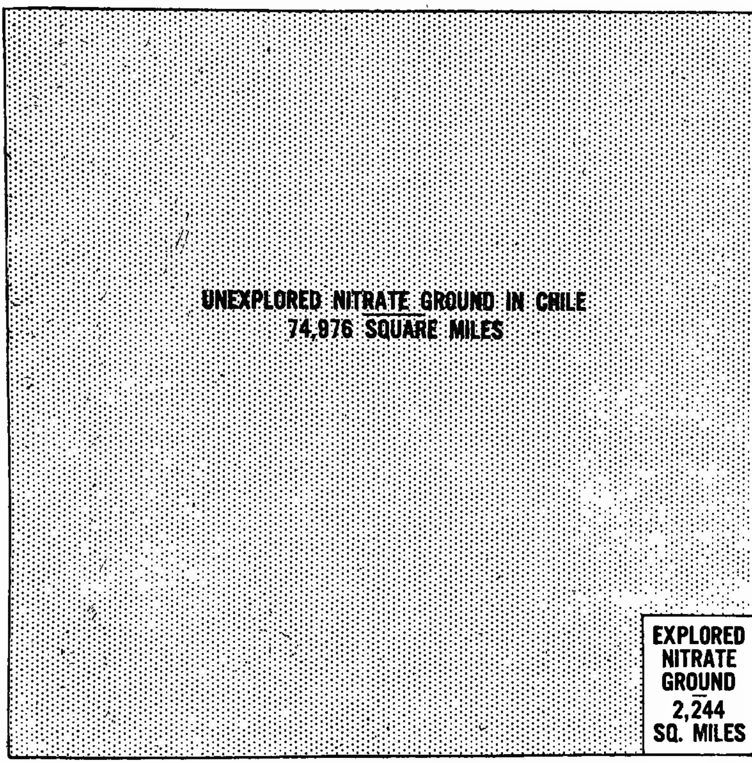
General East and West Section of the Nitrate District of Chile.
Vertical Scale Exaggerated.

Nitrate of Soda is usually applied at the rate of from 100 to 200 pounds per acre on land previously dressed with farm-yard manure. To secure an even distribution, the Nitrate should be well mixed with from three to five parts of fine loam or sand.



Much has been said and written about Nitrate of Soda exhausting the soil. This is all a mistake and is the outcome of incorrect reasoning. Nitrate of Soda does not exhaust soils. It promotes the development of the leafy parts of plants, and its effects are at once noticeable in the deep, rich green, and vigorous growth of crops. The growth of plants is greatly energized by its

use, for the Nitrate in supplying an abundance of nitrogenous food to plants, imparts to them a thrift and vigor which enables their roots to gather in the shortest time the largest amount of other needed foods from a greater surface of surrounding soil. The increased consumption of phosphoric acid and potash is due to the increase in the weight of the crop. The office of the Nitrate is to convert the raw materials of the soil into a crop; for we

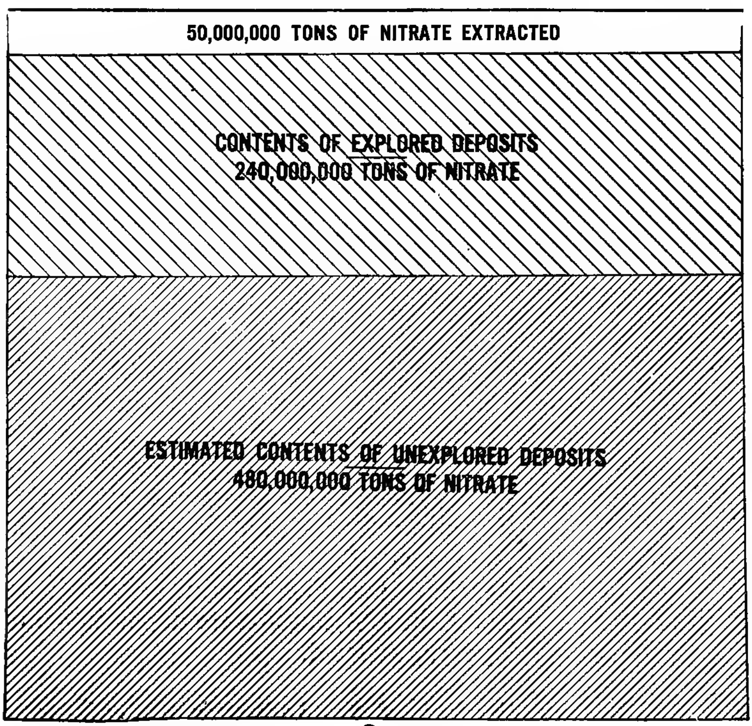


obtain by its use, as Dr. Griffiths has tersely said, " the fullest crop with the greatest amount of profit, with the least damage to the land."

HOW NITRATE BENEFITS THE FARMER.

What Nitrate Looks Like; Its Chemical Properties.

Nitrate of Soda, from the standpoint of the agricultural chemist, is a substance formed by the union of nitric oxide and soda. In appearance it resembles coarse salt. In agriculture, it is valuable chiefly for its active Nitrogen, although it is also a soil sweetener and is frequently capable of rendering soil potash available.



What it is in Agriculture.

Commercially pure Nitrate contains about 15 per cent. of Nitrogen, equivalent to 18.25 per cent. of Ammonia, or 300 pounds of Nitrogen to the ton.

Where it is Found.

Nitrate of Soda is found in vast quantities in Chile. The beds of Nitrate, or "Caliche," as it is called in Chile before it is refined, are several thousand feet above the sea, on a desert plain extending for seventy-five miles north and south, and about twenty miles wide, in a rainless region. The surface of the desert is covered with earth or rock, called "costra," which varies from three to ten or more feet in thickness. Under this is found the "Caliche," or crude Nitrate. The layer of "Caliche" is sometimes eight or ten feet thick, but averages about three feet. This "Caliche" contains on an average from 15 to 50 per cent. of pure Nitrate of Soda.

It is calculated there is ample Nitrate now in sight to last upwards of three hundred years.

Method of Refining.

The "Caliche" is refined by boiling in water to dissolve the Nitrate. This hot water is then run off and allowed to cool in tanks, when the Nitrate forms in crystals like common salt. The Nitrate is then placed in bags of a little over two hundred pounds each and shipped to all parts of the world.

The process of refining is an expensive one. How these beds of Nitrate were formed has been the subject of much speculation. The generally accepted theory is, that they were formed by the gradual decomposition and natural manurial fermentation of marine animal and vegetable matter, which contains a considerable amount of Nitrogen.

The same wise Providence that stored up the coal in the mountains of Pennsylvania to furnish fuel for people when their supply of wood had become exhausted, preserved this vast quantity of Nitrate of Soda in the rainless region of Chile, to be used to furnish crops with the necessary Nitrate when the natural supply in the soil had become deficient.

Its Uses.

The enormous explosive industry of this country could not be conducted without Nitrate of Soda, and glass works are dependent upon it. In fact, glass works and powder works usually have Nitrate on hand.

Its Position in Modern Agriculture.

Nitrate of Soda has a special bearing on the progress of modern agriculture, being the most nutritious form of Nitrogenous or ammoniate plant food. While the action of micro-organisms with certain crops (legumes) combines and makes effective use of the inert Nitrogen of the atmosphere, such action is far too slow and uncertain for all the requirements of modern agriculture, for it is not available for use for a whole year or even longer. The rapid exhaustion of combined Nitrogen has several times been noticed by eminent scientific men, with reference to food famine, because of a lack of the needful Nitrogenous plant food.

Wasteful Methods by our Pioneer Farmers.

It has been estimated under the present methods of cropping the rich lands of our Western States, that for every pound of Nitrogen actually used to make a wheat crop, four to five pounds are utterly wasted. In other words, our pioneer agriculture has proceeded as though fertility capital could be drawn upon forever.

Eminent Scientists the World Over Well Acquainted with the Great Value of Nitrate.

This injudicious waste is already reducing the yield of many of the best lands, rendering the use of at least a small application per acre of Nitrate both profitable and necessary. The agricultural value of Nitrate of Soda has had the attention of the foremost agricultural and scientific specialists of the world, including such men as Lawes and Gilbert, Sir William Crookes, Dr. Dyer, Dr. Hall and Dr. Voelcker, in England; Professors Grandeau, Cassarini, Migneaux, and Cadoret, in France; Professors Bernardo and Alino, in

Spain; Dr. Wagner and Professor Maercker, of Germany; and Drs. Voorhees, J. G. Lipman, Brooks, Duggar, Ross, Patterson, Hilgard and Garcia in America. The results obtained by these officials may be summarized as follows:

1. Nitrate of Soda acts very beneficially and with great certainty upon all straw-growing plants.

2. It is of special value for forcing the rapid development and early maturity of most garden crops.

3. It is of great importance in the production of sugar beets, potatoes, hops, fodder crops, fiber plants, and tobacco.

4. It is exceedingly valuable in developing and maintaining meadow grass and pasture lands.

5. In the early stages of development it produces favorable results upon peas, vetches, lupines, clover, and alfalfa.

6. It has been applied with much advantage to various kinds of berries, bush fruits, vineyards, orchards and nursery stock, and small fruits generally.

7. It provides the means in the hands of the farmer, for energizing his crops so that they may better withstand the ravages of drought, or the onslaughts of plant diseases or insect pests, such as boll weevil, and others.

8. It may be used as a surface application to the soil, from time to time, should the plants indicate a need of it by their lack of color and growth.

9. It is immediately available, and under favorable conditions its effect upon many crops may be noticed within a few days after its application.

10. It may be used either as a special fertilizer, or as a supplemental fertilizer.

11. The best results are obtained from its application when the soil contains ample supplies of available phosphoric acid and potash. It should be remembered that it furnishes the one most expensive and necessary element of plant food, namely, Nitrogen, and of the various commercial forms of Nitrogen, Nitrate is the cheapest.

12. Its uniform action seems to be to energize the capacity of the plant for developing growth. Its action is characterized by imparting to the plant a deep green, healthy appearance, and by also causing it to grow rapidly and to put out numbers of new shoots.

13. The immediate effect of an application of Nitrate of Soda, therefore, is to develop a much larger plant growth and its skillful application must be relied upon to secure the largest yields of fruits and grain.

14. Under favorable conditions of moisture and cultivation, these effects may be confidently anticipated upon all kinds of soils.

15. All of the plant food contained in Nitrate of Soda is available and existing in a soluble form. The farmer should understand that it is not economical to apply more of it than can be utilized by the crop; one of the most valuable qualities of this fertilizer being that it need not lie dormant in the soil from one season to the next.

16. The best results are secured when it is applied during the early growing period of the plant. If applied too late in the development of the plant, it generally has a tendency to protract its growing period and to delay the ripening of the fruit, as after a liberal application of Nitrate of Soda, the energies of the plant are immediately concentrated upon developing its growth. This is true with a few exceptions.

17. The farmer must not expect it to excuse him from applying proper principles of land drainage, or cultivation of the soil, nor should Nitrate of Soda be used in excessive quantities too close to the plants that are fertilized with it. For most seeded crops, an application of one hundred pounds to the acre is sufficient when it is used alone.

18. It may be applied in a dry state to either agricultural or garden lands by sowing it broadcast, or by means of any fertilizer-distributing machine. It can be applied to the surface, or it may be cultivated into the soil by some light agricultural implement,

such as a harrow, weeder, cultivator or horse hoe. The capillary movement of the soil waters will distribute it in the soil, and osmosis of soil solutions and the capillary attraction of the soil particles when in good tilth will retain it safely until the plant uses it.

Accepting the conclusions of these scientific men, the use of Nitrate of Soda in agriculture ought to increase proportionately to the dissemination of the knowledge of its usefulness among our farmers. An increase in the consumption of Nitrate among growers of tobacco, fiber plants, sugar beets, the hop, grape, grass and small fruits, has been most notable of late. The element of plant food first exhausted in soils is Nitrogen, and in many cases a marked increase in crop is obtained through the use of Nitrate alone. " Complete " fertilizers are generally rather low in Nitrogen, and Nitrate may be wisely used to supplement them, as it is practically the cheapest form of plant food Nitrogen.

Its Use Is Increasing.

" Complete Fertilizers " and " Phosphates " the Most Expensive Plant Food.

By " complete fertilizers," is meant fertilizers containing Nitrogen, phosphoric acid and potash. These fertilizers are often called " phosphates," and people have fallen into the habit of calling any commercial fertilizer a " phosphate," whether it contains phosphate or not. Many so-called " complete fertilizers " are merely acid phosphates with insignificant amounts of the other essential plant foods. They are frequently ill-balanced rations for all crops.

The value of these " phosphates," no matter how high sounding their names, consists in their phosphoric acid and potash in many cases.

The Nitrogen contained in these " complete fertilizers " is often in a form that is neither available nor useful to the plants until it has become converted into Nitrate. The time required to do this varies from a few

days to a few years, according to the temperature of the soil and the kind and condition of the material used.

Statistics gathered by the Experiment Stations show that in the United States many millions of dollars are spent annually for " complete fertilizers."

How to Save Money on Fertilizers.

Would you not think a man very unwise who should buy somebody's " Complete Prepared Food," at a high price, when he wanted feed for his horses, instead of going into the market and buying corn, oats and hay, at market prices?

The " Complete Prepared Food " would probably be composed of corn, oats and hay mixed together, and the price would be, perhaps, twice as much as the corn, oats and hay would cost separately. It is frequently more economical to buy the different fertilizing materials and mix them at home than to purchase " complete " fertilizers as they are often called. Some do not wish to take pains to get good materials and mix them, and prefer to purchase the " complete " fertilizers. If this be done, special attention should be given to ascertaining in what form the Nitrogen exists. Many of the manufacturers do not tell this, but some of the experiment stations analyze all the fertilizers sold in their respective states and publish the results in bulletins, which are sent free to anyone asking for them. These analyses should show in what form the Nitrogen is. The " complete fertilizers " that contain the most Nitrogen in the form of Nitrate are the ones to use, and the ones which do not contain Nitrate or which do not give information on this vital point should be avoided. If you have on hand a " complete fertilizer " containing a small percentage of Nitrogen, and only in organic form, such as cotton-seed, or " tankage," it will be of great advantage to use one hundred pounds per acre of Nitrate of Soda in addition to it. No fertilizer is really complete without Nitrate of Soda.

What Fertilizers to Buy.

It is now known that the Nitrogen in organic matter of soil or manure is slowly converted into the Nitrate form by a minute organism. This cannot work if the soil is too cold, or too wet, or too dry, or in a sour soil. As a general rule, soils must be kept sweet and the other conditions necessary for the conversion of the Nitrogen into the Nitrate form are warm weather and a moist soil in good physical condition.

In the early spring the soil is too wet and too cold for the change to take place. We must wait for warm weather. But the gardener does not want to wait. He makes his profits largely on his early crops. Guided only by experience and tradition, he fills his land with manure, and even then he gets only a moderate crop the first year. He puts on seventy-five tons more manure the next year, and gets a better crop. And he may continue putting on manure till the soil is as rich in Nitrogen as the manure itself, and even then he must keep on manuring or he fails to get a good early crop. Why? The Nitrogen of the soil, or of roots of plants, or manure, is retained in the soil in a comparatively inert condition. There is little or no loss. But when it is slowly converted into Nitrate during warm weather, the plants take it up and grow rapidly.

How, then, is the market gardener to get the Nitrate absolutely necessary for the growth of his early plants? He may get it, as before stated, from an excessive and continuous use of stable manure, but even then he fails to get it in sufficient quantity.

One thousand pounds of Nitrate of Soda will furnish more Nitrogen to the plants early in the spring than the gardener can get from 100 tons of well-rotted stable manure. The stable manure may help furnish Nitrate for his later crops, but for his early crops the gardener who fails to use Nitrate of Soda is blind to his own interests.

On What Crops Nitrate Should Be Used.

A given quantity of Nitrate will produce a given amount of plant substance. A ton of wheat, straw and grain together, contain about 1,500 pounds of dry matter, of which 25 pounds is Nitrogen. To produce a ton of wheat and straw together would require, therefore, 170 pounds of Nitrate of Soda, in which quantity there is 25 pounds of Nitrogen.

A ton of cabbage, on the other hand, contains about 4½ pounds of Nitrogen. To produce a ton of cabbage, therefore, would require 30 pounds of Nitrate of Soda.

Fertilizers for Vegetables and Small Fruits.

There are no crops on which it is more profitable to use fertilizers than on vegetables and small fruits, provided they are used rightly. Failures with chemical fertilizers are caused usually by lack of knowledge. There is no doubt but that stable manure is available as a fertilizer, and in some cases may be indispensable, but at the same time the *quantities* necessary to produce good results could be greatly reduced by using chemical fertilizers to supply plant *food* and only enough manure to give lightness and add humus to the soil.

What Fertilizers to Use for Garden Crops.

For crops like cabbage and beets, that it is desirable to force to rapid maturity, the kind of plant food, especially of Nitrogen, is of the greatest importance. Many fertilizers sold for this purpose have all the Nitrogen they contain in insoluble and unavailable form, so that it requires a considerable time for the plants to get it. Another fault is that they do not contain nearly enough Nitrogen. Stable manure contains on the average in one ton 10 pounds Nitrogen, 10 pounds potash, and only 5 pounds phosphoric acid, while the average "complete" fertilizer contains more than *twice* as much phosphoric acid as Nitrogen, a most unnatural and unprofitable ration. A ratio of 2 Nitrogen, 2 potash, and 8 of phosphoric acid, is frequent in many

of the so-called "complete fertilizers," which are really incomplete and unbalanced as well. A fertilizer for quick-growing vegetables should contain as much Nitrogen as phosphoric acid, and at least half this Nitrogen should be in the form of Nitrate, which is the only immediately available nitrogenous plant food.

Comparative Availability of Nitrogen in Various Forms.

Some interesting and valuable experiments were made at the Connecticut Experiment Station, to ascertain how much of the Nitrogen contained in such materials as dried blood, tankage, dry fish, and cotton-seed meal, is available for plants.

The experiments were made with corn, and it was found that when the same quantity of Nitrogen was applied in the various forms the crop increased over that where no Nitrogen was applied, as shown in the following table:

Increase of Crop from Same Quantity of Nitrogen from Different Sources.

Sources of Nitrogen	Relative Crop Increase
Nitrate of Soda	100
Dried Blood	73
Cotton-seed Meal	72
Dry Fish	70
Tankage	62
Linseed Meal	78

This table shows some interesting facts. It is evident that only about three-fourths as much of the Nitrogen in dried blood or cotton-seed meal as in Nitrate of Soda is available the first season. The Nitrogen in tankage is even less available, only a little over half being used by the crop.

These experiments were made with corn, which grows for a long period when the ground is warm and the conditions most favorable to render the Nitrogen in organic substances available, and yet only part of it could be used by the crop.

When it is considered that Nitrogen in the form of Nitrate of Soda can be bought for as little or less per

pound than in almost any other form, the advantage and economy of purchasing and using this form is very apparent.

Proof Positive

In a twenty year test to determine the value of various sources of Nitrogen, the New Jersey Experiment Station found that crop yields and the percentage of Nitrogen *recovered in the crop* were greater when Nitrates were used.

Official figures are —

" If we assign to Nitrate Nitrogen a value of 100, then the relative availability of the four materials stands as follows:

Nitrate of Sode	100.0
Ammonium Sulfate	76.1
Dried Blood	62.0
Manure	52.4

This research was published in " Soil Science," April, 1918.

The Leading Question.

Nitration as studied by means of the drainage water of 6 plots of land, each 300 square yards in area, during 4 years, shows that the loss of Nitrogen in the drainage water was practically negligible. Even when Nitrogen was applied in the spring the losses were not large unless heavy rains occurred at the time. The Nitrogen is apparently rapidly taken up by the young growing plants at this season of the year and only a small portion is free to pass into the drainage. The greatest losses occur in the fall, when the soil is bare and heavy rains occur, the Nitrates having accumulated in large quantities during the warmer period of the year. Large losses at this season are, however, prevented by the growing of cover crops.

How to Apply Phosphatic Fertilizers.

In applying fertilizers it should be remembered that any form of phosphoric acid, such as acid phosphate, dissolved bone-black or bone meal is only partially soluble, and will not circulate freely in the soil. These fertilizers should, there-

fore, be evenly distributed over the soil and well mixed with it. This is usually best done by applying broadcast before sowing the seed and before the ground is thoroughly prepared.

Nitrate of Soda, on the other hand, will diffuse itself thoroughly throughout the soil if there is enough moisture to dissolve it. It can therefore be applied by scattering on the surface of the ground.

How and Where to Buy Fertilizing Materials.

Since Nitrate of Soda and salts of potash are brought to this country by sea, and phosphate is usually transported from the mines in vessels, all these materials, as a rule, can be purchased at the seaports, cheaper than in the interior. New York is the largest market for these materials, but Philadelphia, Baltimore, Charleston, Savannah, Mobile, New Orleans, Galveston, San Francisco, Portland and Seattle, are also ports of entry.

Lower prices can be obtained by buying fertilizing materials in carload lots. If you cannot use a carload yourself, get your neighbors to join with you. Much money has often been saved in this way.

In buying, always consider the percentage of availability.

This may be illustrated by comparing gold ores of the same percentages derived from different sources,— one gold ore containing ten ounces to the ton might be worth a great deal of money per ton,— that is to say, if the ore were extractable with ease and without undue expense,— whereas another ten-ounce ore might contain its gold in such form as to be extracted only with great difficulty and at great expense.

HOW TO USE CHEMICAL FERTILIZERS TO ADVANTAGE.

How Nitrate Increases Wheat Crops.

The form of Nitrogen most active as plant food is the nitrated form, namely: Nitrate of Soda. All other Nitrogens must be converted into this form before they can be used as food by plants. Sir John Lawes wisely remarks: "When we consider that the application of a few pounds of Nitrogen in Nitrate of Soda to a soil which contains several thousand pounds of Nitrogen in its organic form, is capable of increasing the crop from 14 to 40 or even 50 bushels of wheat per acre, I think it must be apparent to all that we have very convincing evidence of the value of Nitrate." The Nitrogen of Nitrate of Soda is immediately available as plant food, and it should therefore be applied only when plants are ready to use it. By such a ready supply of available plant food, young plants are able to establish such a vigor of growth that they can much better resist disease, and the attacks of insects and parasites. The famous experiments of Lawes and Gilbert at Rothamsted have demonstrated that cereals utilize more than three times as much of the Nitrogen in Nitrate of Soda as of the Nitrogen contained in farmyard manure; in practice, four and one-half tons of farmyard manure supply only as much available plant food as 100 pounds of Nitrate of Soda.

Nitrate Compared with Farmyard Manure.

Catch-Crops.

Catch-crops are recommended to prevent losses of available plant food after crops are removed. Rape, Italian rye grass, rye, thousand-headed kale and clovers are suitable. All these should be top-dressed with from 100 to 200 pounds per acre of Nitrate of Soda, depending upon the exhaustion of the soil. In our remarks on the use of Nitrate, we have taken it for granted that our readers

fully understand that in all cases where Nitrate has been recommended in large amounts, potash and phosphates should be used also unless the soil already contains ample supplies of both.

The most important material used to supply Nitrogen, in the composition of commercial fertilizers is Nitrate of Soda. Nitrate of Soda is particularly adapted for top-dressing during the growing season, and is the quickest acting of all the nitrogenous fertilizers.

Dried blood, tankage, azotine, fish scrap, castor pomace, and cotton-seed meal represent fertilizers where the Nitrogen is only slowly available, and they must be appled in the fall so as to be decomposed and available for the following season. Nitrogen in the form of Nitrate of Soda is available during the growing and fruiting season, possessing, therefore, a decided advantage over all other Nitrogen plant foods.

Chemical Composition of Soils.

Sandy soils may be described as soils containing seventy-six (76) per cent. or more of sand.

Sandy loam is a soil containing seventy-five (75) per cent. less of sand, and a loam is said to be a soil containing forty (40) to fifty-nine (59) per cent. of sand.

Clay loam runs between twenty-nine (29) to thirty-nine (39) per cent. of sand, and a clay soil would be described as a soil containing about sixty-one (61) per cent. or more of clay.

A very rich soil may be described as a soil containing 2 per cent. of lime and 18.80 per cent. of potash and from .02 to .10 per cent. of sulphuric acid, in the form of sulphate, and from .10 to .30 per cent. of phosphoric acid, in the form of phosphates, with humus running from 1.20 per cent. to 2.20 per cent. and Nitrogen from .20 to 1 per cent.

According to French authorities a good soil would contain .20 per cent. of Nitrogen and .20 per cent. of phosphoric acid, in the form of phosphates, and .30 per cent. of potash.

Anything above these figures would be called very rich. Very poor soil would average about .08 per cent. of Nitrogen and .08 per cent of potash and .08 per cent. of phosphoric acid with humus of .30 per cent. Anything less than these figures would be very poor indeed.

The pounds of available fertility are reckoned to be contained within eight (8) inches of the surface. The weight of an acre generally would run about two thousand (2,000) tons.

HOW MONEY CROPS FEED.

What the Food Is.

The substance of plants is largely water and variations of woody fiber, yet these comprise no part of what is commonly understood as plant food. More or less by accident was discovered the value of farmyard manures and general farm refuse and roughage as a means of increasing the growth of plants. In the course of time, the supply of these manures failed to equal the need, and it became necessary to search for other means of feeding plants. The steps in the search were many, covering years of careful investigation, and as a result, we have the established fact that the food of plants consists of three different substances, Nitrogen, Potash, and Phosphates.

Its Principal Elements, Nitrate, Phosphoric Acid, Potash.

These words are now popular names, and are used for the convenience of the general public. Nitrate of Soda contains an amount equivalent to about 15 per cent. of Nitrogen, 300 pounds to the ton, and cotton-seed meal, for example, about 6 per cent. More than three pounds of cotton-seed meal are necessary to furnish as much available Nitrogen as one pound of Nitrate of Soda. We value the plant food on the amount of Nitrate Nitrogen it contains, and on this account Nitrate has become a standard name for this element of plant food. In like manner, phosphoric acid and potash are standards, hence

the importance of farmers and planters familiarizing themselves with these expressions. We always should think of fertilizers and manures as just so much Nitrate, phosphoric acid and potash, as we can then at once compare the usefulness of all fertilizer materials. No doubt, other substances are necessary for the proper development of crops, but soils so generally supply these in ample quantities that they may safely be neglected in a consideration of soil needs and plant foods. The food of plants may therefore be understood to mean simply *Nitrate, Phosphoric Acid and Potash.*

Why Farmyard Manure and Other Products Are Valuable.

Farmyard manure acts in promoting plant growth almost wholly because it contains these three substances; green manuring is valuable for the same reason and largely for that only. Various refuse substances, such as bone, wood ashes, etc., contain one or more of these plant food elements, and are valuable to the farmer and planter on that account.

The Quality of Manures and Fertilizers.

Nitrate Pre-digested Nitrogen.

While plant food is always plant food, like all other things it possesses the limitation of quality. Quality in plant food means the readiness with which plants can make use of it. In a large sense, this is dependent upon the solubility of the material containing the plant food — not merely solubility in water, but solubility in soil waters as well. Fertilizer substances freely soluble in water are generally of the highest quality, yet there are differences even in this. For example, Nitrate of Soda is freely soluble in soil liquids and water, and is the highest grade of plant food Nitrogen; sulphate of ammonia is also soluble in water, but of distinctly lower quality because plants always use Nitrogen in the Nitrate form, and the Nitrogen in sulphate of ammonia must be nitrated before plants can

make use of it. This is done in the soil by the action of certain organisms, under favorable conditions. The weather must be suitable, the soil in a certain condition; and besides there are considerable losses of valuable substance in the natural soil process of nitrating such Nitrogen. By unfavorable weather conditions, or very wet or acid soils, nitration may be prevented until the season is too far advanced, hence there may be loss of time, crop and money.

Defects and Losses in the Use of Ordinary Nitrogens.

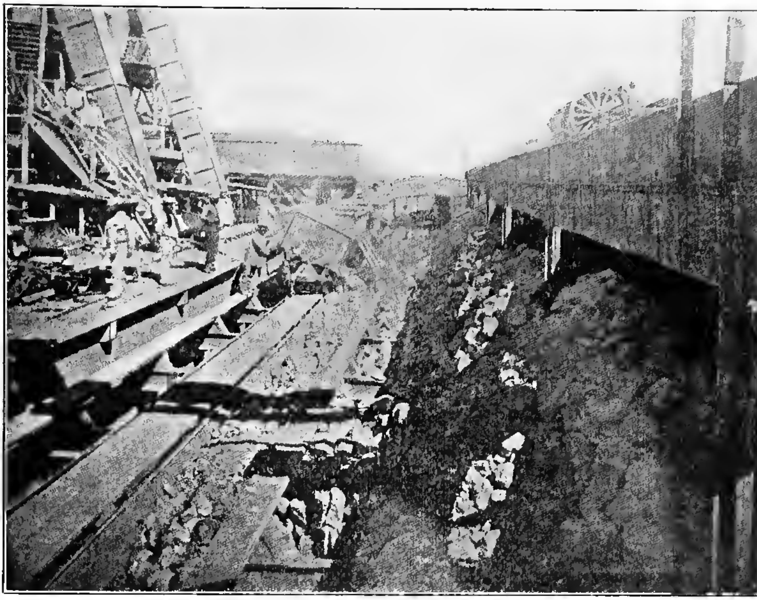
The quality of nitrogens, such as cotton-seed meal, dried fish, dried blood, and tankage, is limited by conditions similar to those which limit sulphate of ammonia. With these substances, the loss of Nitrogen in its natural air and soil conversion into Nitrate is very great. Perfectly authentic experiments, and made under official supervision, have shown that 100 pounds of Nitrogen in these organic forms have only from one-half to three-fourths the manurial value of 100 pounds of Nitrate of Soda.

Intrinsic Values of All Nitrogens Based on Nitrate as the Standard.

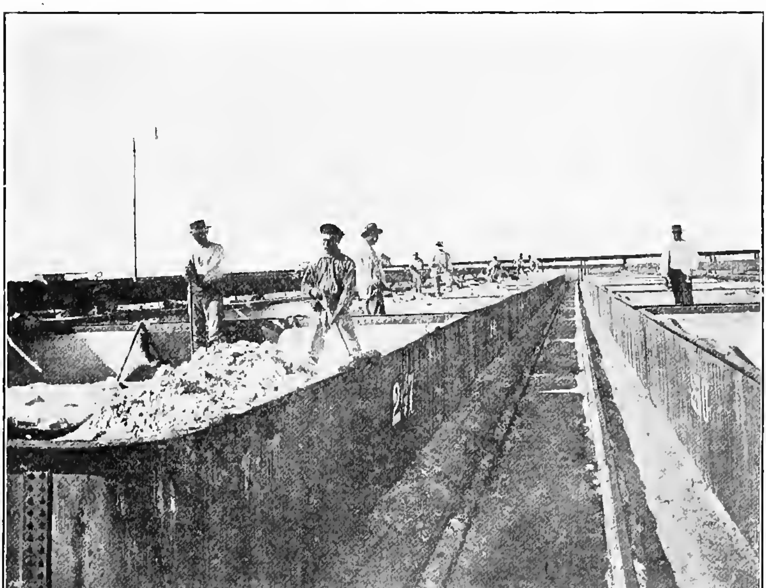
Special Functions of Plant Food.

Unusual Functions of Nitrate.

As stated before, plants must have all three of the plant food elements — Nitrate, Phosphates and Potash — but notwithstanding this imperative need, each of the three elements has its special use. There are many cases in which considerations of the special functions of plant food elements become important. For example, a soil may be rich in organic ammonia from vegetable matter turned under as green manure, and through a late wet spring fail to supply the available Nitrate in time to get the crop well started before the hot, dry, summer season sets in. In this case the use of Nitrate of Soda alone will force growth to the extent of fully establishing the crop against heat and moderate drouth.



Top of Caliche Hopper; Carts Tipping Caliche.



Crystallizing Pans After Running Off Mother-liquor, Showing Deposit of Nitrate Crystals.

Special Influence of Nitrate on Edible Value of Plant.

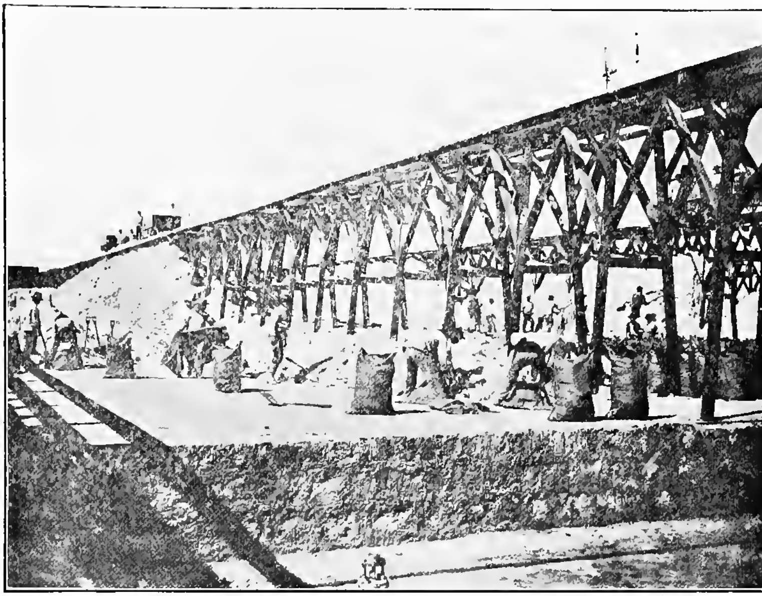
Nitrate as plant food seems to influence more especially the development of stems, leaves, and roots, which are the framework of the plant, while the formation of fruit buds is held in reserve. This action is, of course, a necessary preliminary to the maturity of the plant, and the broader the framework, the greater the yield at maturity. The color of the foliage is deepened, indicating health and activity in the forces at work on the structure of the plant. Nitrates also show markedly in the economic value of the crop; the more freely Nitrates are given to plants the greater the relative proportion in the composition of the plant itself, and the most valuable part of all vegetable substances, for food purposes, is that produced by Nitrate of Soda. Nitrate is seldom used in sufficient quantities in the manufacture of "complete fertilizers."

Potash as plant food seems to influence more particularly the development of the woody parts of stems and the pulp of fruits. In fact, this element of plant food seems to supplement the action of Nitrate by filling out the framework established by the latter.

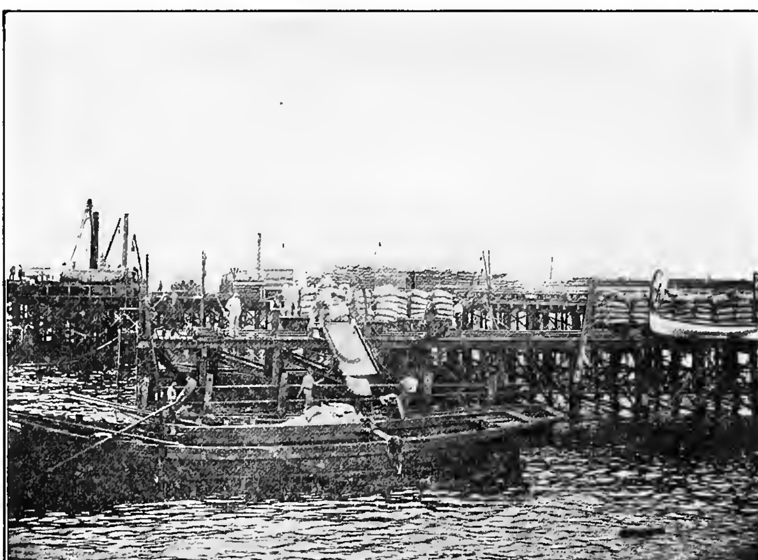
Phosphoric acid as a plant food seems to influence more particularly the maturity of plants and the production of seed or grain. Its special use in practical agriculture is to help hasten the maturity of crops likely to be caught by an early fall, and to supplement green manuring where grain is to be grown. It is frequently used in altogether unnecessary excess in " complete " fertilizers.

Sources of Natural Plant Food.

The natural plant food of the soil comes from many sources, but chiefly from decaying vegetable matter and the weathering of the mineral matter of the soil. Both these processes supply potash and phosphoric acid, *but only the former supplies Nitrate.* Whether the soil has been fertilized or not, there are certain signs which indicate the need of plant food more or less early in the growth of the crop. If a crop

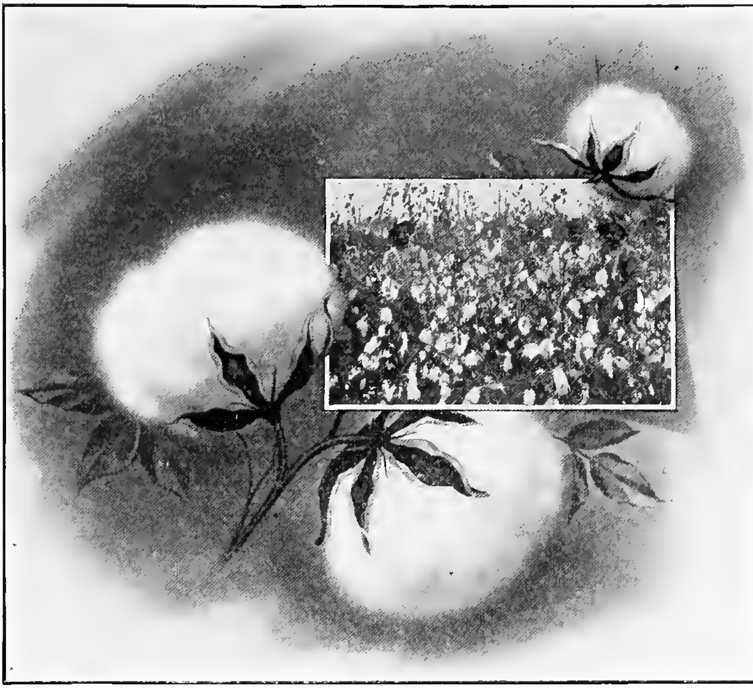


Packing Nitrate into Bags.



Loading Lighters.

appears to make a slow growth, or seems sickly in color, it does not greatly matter whether the soil is deficient in Nitrate or simply that the Nitrogen present has not been nitrated and so is not available, the remedy lies in the use of the immediately available form of Nitrate of Soda.



Cotton and Fiber Plants.

Cotton is profitably grown on nearly all kinds of soil, but does best perhaps on a strong, sandy loam. On light uplands the yield is light, but with a fair proportion of lint; on heavy bottom lands the growth may be heavy, but the proportion of lint to the whole plant much reduced.

The preparation of the soil must be even and thorough. About one bushel of seed per acre is the usual allowance.

Many fertilizer formulas have been recommended, and by all kinds of authority, and green manuring is widely advised as a means of helping to get a supply of cheap Nitrogen; but, with this crop especially, cheap forms of Nitrogen are very dear.

REPORT ON ALABAMA COTTON PRIZE EXPERIMENTS WITH CHEMICAL FERTILIZERS.

Extended experiments have been made from year to year by all the Experiment Stations in the various cotton-growing states with a view to arriving at the fertilizer requirements of the cotton plant under the varying conditions of soil and climate which are met with throughout the cotton belt, and the needs of the plant for the various essential fertilizing elements have been determined with comparative accuracy.

The farmer, himself, however, is often inclined to pay little attention to the forms in which the fertilizing elements are applied, even though he may employ sufficient quantities of a given mixed fertilizer to supply the proper quota of each element. As a matter of fact, the selection of a proper form or forms in which to supply the needed plant foods will, in many cases, determine the success of the application of a given formula to the crop, and too much care and attention cannot be given to this important question.

Many of the formulas for cotton and corn which are in use throughout the cotton-growing states supply proportions of Nitrogen, and, in some cases, of potash, which are far below the fertilizer requirements of the crop, while as before stated little attention is given to the matter of supplying these elements in forms most available for the needs of the plant.

Analyses of the cotton plant, made at the South Carolina, Mississippi and Alabama Experiment Stations, show the needs of the plant for liberal supplies of Nitrogen and of potash, particularly of the former element, since our average cotton soils are, as a rule, so poorly supplied with it.

At the Albama Experiment Station in 1899 (Bulletin 107), analyses were made of all portions of the cotton plant at various stages of growth, including the plant at full maturity. The weight of the various fertilizing constituents contained in the whole plant grown on one acre, and producing a crop equivalent to 300 pounds dry

lint cotton per acre, was also carefully ascertained by analyses and calculation, the figures being presented in the following table.

The weight of Nitrogen, phosphoric acid, potash, and lime contained in a crop producing 300 pounds of lint is given, and the relative distribution of these constituents through different parts of the plant is also presented. The weights of the different parts of the plant in a thoroughly dried condition are also given, and it will be noted that the *total dry weight of the crop required to yield* 300 *pounds of lint is* 2,470.8 *pounds.*

TABLE VIII.

Amounts of Fertilizer Constituents in Pounds Required to Produce a Crop of 300 *Pounds of Lint.*

	Nitrogen	Phosphoric Acid	Potash	Lime
Lint — 300 lbs.	0.54	0.27	1.77	0.21
Seed — 507.1 lbs.	17.95	7.10	5.73	1.52
Burrs — 363.1 lbs.	2.99	1.74	11.22	4.14
Leaves — 566.2 lbs.	12.64	2.70	6.13	29.90
Roots — 130.2 lbs.	0.62	0.34	1.17	0.59
Stems — 604.2 lbs.	3.87	1.27	5.14	4.71
Total — 2,470.8 lbs.	38.61	13.42	31.16	41.07

It appears from this table that to produce 300 pounds of dry lint there are required 38.61 pounds of Nitrogen, 13.42 pounds of phosphoric acid, 31.16 pounds of potash and 41.07 pounds of lime.

The need of the cotton plant for liberal amounts of Nitrogen being thus indicated by laboratory tests, the writer has during the past two seasons supervised and directed a series of experiments upon the farm of Mr. J. C. Moore, near Auburn, Alabama, who was desirous of securing a formula adapted to the growing of cotton upon the sandy soil of his farm and of the immediate section in which he resided.

This soil is designated by the U. S. Soil Survey of this region as the "Norfolk Sandy Loam." It is described in the official report of the soil survey of Lee county as

follows: "The Norfolk Sandy Loam is an easily tilled soil and the best for general farming of any of the Norfolk types in this country. It is well adapted to cotton and when fertilized produces fair yields of corn and oats. The lightest phase is well adapted to the production of potatoes, berries and truck crops. The soil needs organic matter which may be supplied by green or stable manure."

The cotton experiments conducted upon the farm of Mr. Moore were carried out upon several plots aggregating in area two-thirds of an acre.

Products of Plots, 1905.

Yields of Seed Cotton.

Plot 1.	Plot 3.	Plot 4.
750 lbs.	1,272 lbs.	1,440 lbs.

The land, after proper preparation, was laid off in rows seventy yards in length, while the distance between the rows was so adjusted that ten rows would constitute a plot of one-sixth of an acre. Two blank rows were left

between the individual plots so that the fertilizers applied to one plot would not have any undue effect upon the adjacent plots.

Plot No. 1 was fertilized by the application of an acid phosphate containing 14 per cent. available phosphoric acid and 4 per cent. potash, this fertilizer being applied at the rate of 300 pounds per acre.

Products of Plots, 1906.

Yields of Seed Cotton.

Plot 1.	Plot 3.	Plot 4.
930 lbs.	1,284 lbs.	1,776 lbs.

The remaining three experimental plots of ten rows each (covering an area of one-sixth acre each) were also fertilized by the application of the same quantity of the above mentioned acid phosphate containing potash, and, in addition, Nitrate of Soda was applied to plots 2, 3 and 4 in the proportions of 42, 84 and 126 pounds per acre, respectively, while no Nitrate or other form of Nitrogen was applied to plot No. 1.

The yields per acre for the different plots for the years 1905 and 1906 were as follows:

1905......	750 lbs. seed cotton.	1,116 lbs.	1,272 lbs.	1,440 lbs.
1906......	930 lbs. seed cotton.	900 lbs.	1,284 lbs.	1,776 lbs.

As above stated, all of these plots were fertilized equally as regards the amount of phosphoric acid and potash, so that the effects of supplying or withholding Nitrate of Soda could be easily noted.

It will be noted that the increased yields are particularly striking in the case of the application of 84 and 126 pounds of Nitrate. On plot 2, in 1906, the yield was practically the same as that on plot 1, but this was due to the fact that a few rows in plot 2, owing to the stand on a part of the plot being not so good and possibly on account of some other condition, brought down the average yield per row of that plot. A majority of the rows of that plot, however, undoubtedly gave a better yield than plot No. 1, and it was apparent to the eye that most of this plot was superior to plot No. 1.

In 1905 it was noted that the cotton grown upon the "No Nitrate" plot rusted quite badly, while plots 3 and 4, upon which an abundance of Nitrate had been applied, were almost immune from rust.

In addition to experiments in which the Nitrate was applied at a single application, tests were made upon some smaller plots to note the effects of the application of the Nitrate in two different applications, the second application being made about sixty days after planting. It was found that there was only a slight difference in the relative yields, but this slight difference was in favor of the two applications. It is doubtful, however, if the increase would have justied the additional cost and labor of the second application.

Experimental tests upon small lots of the seed cotton produced in 1906, showed that the yield of lint was about 34.4 per cent. of the weight of the seed cotton, but no data was secured with regard to the proportionate yield of lint in 1905. Applying these figures to the excess yield

of seed cotton by reason of the application of 126 pounds Nitrate, it will be found that there was an increase of about 238 pounds lint cotton (690 pounds seed cotton) over the yield on the "No Nitrate" plot in 1905 and an increase of 291 pounds lint cotton (846 seed cotton) in 1906. At 10 cents per pound, the increased value of the lint cotton yield by applying 126 pounds Nitrate would be $23.80 for 1905 and $29.10 for 1906, to say nothing of the value of the increased yield of seed which would amount to from $3 to $4, or even more in later years.

With regard to the time and manner of application of the Nitrate in the experiments of the past two years, it should be stated that in 1905 the fertilizers were applied and the cotton planted on April 27th, while in 1906 the date of planting and application of fertilizers was April 21st. The Nitrate was applied in the furrow along with the fertilizing materials at the time of planting.

The views given, herewith, will afford an idea of the comparative yields from plots 1, 3 and 4 in 1905 and 1906. The quantities of seed cotton represented therein are equal to the yields on one-twelfth of an acre.

In this connection it should be stated that Mr. Moore gave a large amount of care and attention to these experiments. By his close personal supervision of the work, the details of the experiments have been secured and most accurately recorded.

Upon comparing the results of these experiments with the results of the Nitrate of Soda tests reported in the January, 1907, Bulletin of the North Carolina Department of Agriculture, it will be noted that the general conclusions which may be drawn from the two sets of experiments are practically the same. A number of the experiments were carried out under almost identical conditions, though the North Carolina plots were somewhat smaller in area, being one-tenth acre area each, while the Alabama plots were one-sixth of an acre.

As an average of the two years' results, the most profitable application, it is stated, was upon the plot receiving 200 pounds acid phosphate, 83 pounds kainit

and 100 pounds Nitrate of Soda, 25 pounds of the Nitrate being applied with other materials at planting, and the remaining 75 pounds reserved and used as a side dressing some two months or more later. This mixture gave an average profit of $21.94 per acre for two years above the yield secured from a plot fertilized with acid phosphate and kainit alone, while with only 75 pounds Nitrate of Soda per acre an increased yield valued at $19.26 was secured!

In the experiments conducted near Auburn, Alabama, no tests were made with quantities of Nitrate of Soda intermediate between 84 and 126 pounds per acre, though it is possible that a quantity somewhat less than 126 pounds might have given practically as satisfactory results as those reported for the maximum applications of Nitrate. In any event, the results of these tests and of other tests upon similar lands in this section show that excellent results may be secured by the application of from 100 to 125 pounds of Nitrate of Soda per acre, in conjunction with the proper quota of acid phosphate and some salt of potash.

The Rational Use of Nitrate of Soda on Cotton in Fighting the Boll Weevil.

Some critics of Nitrate have claimed that it made such a bushy growth of the cotton plant, that it had shaded the bottom part of the plant where most of the cotton is produced under Weevil conditions.

Where any Nitrogenous fertilizer is used in excess, too leafy a growth is apt to result, and excessive quantities of Nitrate, or indeed of any fertilizers, are not recommended.

Quinine is a wonderful remedy, but no one would advise the use of forty grains of it when four grains would be sufficient and satisfactory in every way.

Practice early and thorough preparation of the soil so as to get a good seed bed for quick germination and vigorous early growth of the cotton.

Cotton should be forced as rapidly as possible in its early growth, especially where the Boll Weevil has been long established. An early application of Nitrate is regarded as very helpful in accomplishing this result.

An intelligent rotation is recommended for reducing damage from the Boll Weevil.

Our cotton fertilizer formula, given in the following text, is believed to be a sound one, and when Nitrate is applied early and an early variety of cotton is used, it is believed that such a proceeding is one of the best with which to meet the Boll Weevil situation, and that profitable returns will be made.

Early Versus Late Applications of Nitrate of Soda to Cotton

Proof Positive. The following figures of averages prove positively that early applications of Nitrate of Soda to Cotton give the best results.

1919–1920–1921

Average increase of 23 early applications, 1919....	90.22%
Average increase of 15 late applications, 1919....	42.02%
Average increase of 8 early applications, 1920....	197.35%
Average increase of 4 late applications, 1920......	35.50%
Average increase of 7 early applications, 1921....	61.44%
Average increase of 2 late applications, 1921......	16.30%
Average increase of 38 early applications, 1919–1921	115.21%
Average increase of 21 late applications, 1919–1921	31.27%

April 1–May 11, inclusive, are "Early" applications.
May 12–June 26, inclusive, are "Late" applications.

Instructions for Using Nitrate of Soda on Cotton.

Origin of Cotton. Cotton is one of the oldest of the cultivated plants and is the most valuable fibre in the world. It probably originated in India or China. It was first cultivated in the United States in Virginia.

The Right Variety.

After having selected the right variety for your locality, the best specimens of the plants should be saved for seed. There is a growing demand for the long staple upland varieties. It is just as easy and twice as profitable to feed the thorough-bred plants as it is to feed the low grade lint producer.

Nitrate of Soda Best for Cotton.

Nitrate of Soda is the best top dresser for cotton. Other materials and brands may be offered at less cost per ton, but they as a rule do not contain as much available Nitrogen as is necessary for cotton. They are frequently only very slowly available and require a heavier rate of application, resulting in much higher cost per acre and lower efficiency.

Cotton land should be prepared very early, and thorough deep plowing and cultivation are necessary up to the time the squares form.

Some planters sow crimson clover at the last cultivation of the cotton which protects the soil from washing during the following winter, and provides a certain amount of forage for animals. If the preceding crop is crimson clover it should be plowed under about the middle of February.

Time to Apply Nitrate.

About the time of planting cotton in the spring, apply the Nitrate of Soda by broadcasting it evenly by hand or by machine, over the entire surface of the cotton field you are fertilizing, at the rate of 150 pounds per acre, which in bulk is equal to about 1½ bushels.

We recommend, wherever possible, the application of Nitrate just before the last harrowing of the land before seeding. If this is not possible or convenient, then broadcast before the first cultivation of the cotton. If the time for these earlier applications has passed, apply just before the last cultivation. If put on before planting

time, it should be harrowed in; if put on after planting, it should be cultivated in.

Should the Nitrate become hard, it can readily be pulverized with the back of a shovel, or with a mallet, or it may be crushed on a barn floor by using a heavy post as a roller.

Formula for Cotton

Nitrate alone...........................	150 lbs. per acre
or preferably	
Nitrate	200 " " "
Acid Phosphate.........................	200 " " "

When potash salts can conveniently be obtained we advise the use of fifty pounds of sulphate of potash to the acre every other year.

What Nitrate Has Done in the Planters' Own Hands

H. F. Lyle, Somerville, Ala.:

"Plot with Nitrate produced 207 lbs. Cotton. Plot without Nitrate produced 87 lbs. Cotton.

"Nitrate plot did not shed off fruit in dry weather like the other plot,— in fact, did not shed any. One-third larger stalk. Did not have more than half stand on plots."

B. F. White, Olive Branch, Louisiana:

"Plot with Nitrate produced 90 lbs. Cotton. Plot without Nitrate produced 36 lbs. Cotton.

"The Nitrate of Soda Cotton matured before the Boll Weevil affected it. I consider it the best I ever used,— ahead of any for this climate."

In Alabama the use of 126 pounds of Nitrate per acre for two successive seasons gave an average increased yield of 768 pounds of seed cotton per acre; or an increased yield of lint of 256 pounds per acre in addition to the seed yield of 512 pounds for the same area.

Nitrate Gives Best Results from Early Application.

When Nitrate of Soda is applied early in the season to cotton, as it preferably should be, early maturity results. Too late applications of any nitrogenous fertilizer will delay its maturity.

If the planter has been badly advised, and in consequence applies his nitrogenous fertilizer too late, he should not blame the fer-

tilizer for his cotton having behaved contrary to nature's intent.

What is needed most is to secure complete maturity of the cotton before the short days of early autumn arrive.

Tobacco.

The value of tobacco depends so much upon its grade, and the grade so much upon the soil and climate, as well as fertilization, that general rules for tobacco culture

No Nitrate. Virginia Experiments. 100 lbs. Nitrate of Soda Per Acre.

should not be mathematically laid down. Leaving out special kinds, such as Perique, the simplest classification of tobacco is as follows: *Cigar.*— Tobacco for cigar manufacture, grown chiefly in Connecticut and Wisconsin. *Manufacturing.*— Tobacco manufactured into plug,

or the various forms for pipe smoking and cigarettes. All kinds of tobacco have the same general habits of growth, but the two classes mentioned have very different plant food requirements.

Cigar tobaccos generally require a rather light soil; the manufacturing kinds prefer heavy, fertile soils. In either case, the soil must be clean, deeply broken, and thoroughly pulverized. Fall plowing is always practiced on heavy lands, or lands new to tobacco culture. Tobacco may be safely grown on the same land year after year. The plant must be richly fertilized; it has thick, fleshy roots, and comparatively little foraging power — that is, ability to send out roots over an extensive tract of soil in search of plant food.

Fertilizer for tobacco is used in quantities per acre as low as 400 pounds of high grade and as much as 3,000 pounds of low grade. While the production of leaf may be greatly increased by the use of Nitrate, the other plant food elements should also be used to secure a well matured crop. In the case of cigar tobaccos, Nitrate may be used exclusively as the source of Nitrogen as it is difficult to secure a thoroughly matured leaf unless the supply of digestible Nitrogen is more or less under control, a condition not practicable with ordinary fertilizers.

Tobacco growing is special farming, and should be carefully studied before starting in as a planter. For small plantations, the plants are best bought of a regular seedsman. The cultivation is always clean, and an earth mulch from two to three inches in depth should be maintained — that is, the surface soil to that depth kept thoroughly pulverized.

At the Kentucky Experiment Station, experiments were made with fertilizers on Burley Tobacco. The land was "deficient in natural drainage," so that the fertilizers could hardly be expected to have their full effect. Yet, as will be seen by the following table, the profits from the use of the fertilizers were enormous:

Experiments on Tobacco at the Kentucky Experiment Station.

Fertilizer per acre.	Bright.	Yield of tobacco — pounds. Red.	Lugs.	Tips.	Trash.	Total.	Value of tobacco per acre.
1. No manure	....	200	360	60	540	1,160	$67.20
2. 160 lbs. Nitrate of Soda	230	450	310	90	530	1,610	138.40
3. 160 lbs. sulp. of potash; 160 lbs. Nitrate of Soda..	190	755	605	120	140	1,810	190.45
4. 320 lbs. superphosphate; 160 lbs. sulp. of potash; 160 lbs. Nitrate of Soda...	310	810	420	10	360	2,000	201.20

"The tobacco was assorted by an expert and the prices given as follows: Bright and red, fifteen cents per pound; lugs, six cents per pound; tips, eight cents per pound; trash, two cents per pound."

One hundred and sixty pounds Nitrate of Soda, costing about $3.75, increased the value of the crop $71.20 per acre!

Instructions for Using Nitrate of Soda on Tobacco.

Just before setting out plants, apply the Nitrate of Soda by broadcasting it evenly, by machine, or by hand, over the entire surface of the tobacco field you are fertilizing, at the rate of 150 pounds per acre. One hundred and fifty pounds of Nitrate is equal in bulk to about one and one-half bushels.

Formula for Tobacco.

Nitrate alone	150 lbs. per acre
or preferably	
Nitrate	200 lbs. per acre
Acid Phosphate	200 lbs. per acre

When potash salts can conveniently be obtained we advise the use of fifty pounds of sulphate of potash to the acre every other year.

FERTILIZERS FOR CORN.

Corn varies in yield of grain per acre, according to the character of the soil upon which it is grown, the location of its growth and the variety used. Soils best suited for corn culture are rich, deep loams, naturally well drained and located in those regions where the average temperatures during the growing months of May to September, inclusive, reach from 75 degrees to 80 degrees Fahr. That is, the best climatic conditions do not depend upon average annual temperature, but upon the high temperature maintained during these growing months. The growing season will, however, vary also in different sections of the country, ranging from 90 to 160 days, and varieties exist which are adapted to these different growing periods. The yield is also, of course, influenced by moisture, depending again not altogether upon the total rainfall, but upon the requisite amounts that may be depended upon from May to September, the growing months. The plants need high temperatures and maximum rainfalls throughout July and August, with clear, sunshiny weather between rains.

The variety also has a direct influence upon the yield of the crop, and work done recently in the matter of corn breeding and selection has very considerably broadened the area of profitable culture. The Flint varieties are more suitable for the northern sections, and the Dent varieties for the central and southern sections of the United States.

The Object of Growth — Grain.

Corn is grown mainly for its grain, and for this reason the greatest attention has been given to the development of varieties that will yield the largest proportion of grain to stalk; because, however, of the increasing use of corn as a forage plant, much attention has recently been given to the varieties adapted for soiling and for silage.

In growing corn for these different purposes, different methods are adopted. When the main object is to secure grain, varieties are selected which produce large, uni-

form ears, with deep grains. In order to insure its proper development and ripening, it is planted preferably in hills, at such distances as will permit a maximum amount of sunshine to reach all parts of the plant, and so cultivated as to encourage the largest use of food from soil sources. In other words, every precaution is taken

Fertilizer, 300 Pounds per Acre Minerals and 150 pounds per Acre Nitrate of Soda.
Rate of Yield, 100 Bushels Ears per Acre, excellent quality.

Fertilizer, 300 Pounds per Acre Minerals Only.
Rate of Yield, 80 Bushels Ears per Acre, poor quality.

to insure the largest proportion of ripened grain; the stalks often being regarded as a by-product of little value. In fact, in many parts of the country the stalks are not utilized as they should be, although when well cured they are equivalent in food value, on the dry matter basis, to good timothy hay.

In planting Indian corn for grain we doubtless often plant the seed too thick.

Silage.

When grown for silage, the object is to secure the largest amount of digestible matter per acre. Hence, varieties with larger stalk and leaf are generally used and the corn planted much closer together and thicker in the rows, but not so thick as to prevent many of the stalks from producing ears. When cut when the ears are beginning to glaze, good crops will oftentimes yield as much as 5,000 to 6,000 pounds of dry matter per acre. Larger amounts of plant food than for grain are required, as a rule, in order that the vegetative functions may be increased, hence on most soils, even in a good state of fertility, applications of fertilizers are necessary, more particularly those containing Nitrogen.

One Hundred Bushels of Ears of Corn per Acre, Before Harvesting.

Soiling.

In growing corn for soiling, the object is to obtain the largest amount of succulent food per acre, which may be completely eaten by the animal. Hence, for soiling, quick-growing varieties, with a large proportion of leaf and small stalks, are grown and planted thicker than for silage, and still greater care in the use of manures and fertilizers is required in order to enable the plant to absorb food throughout its entire growth.

Sweet Corn.

When sweet varieties are grown, the object is to obtain a large number of ears suitable for the table. The sweet varieties are less hardy and vigorous than the ordinary field varieties, and are better adapted for light soils, hence the treatment is still different from that used when grown for the purposes already mentioned. The grain is not planted ordinarily until the soil is thoroughly warm, and the temperature is likely to continue high and, because better suited for light soils, special fertilization is necessary.

Corn and Oats, New York Experimental Fields.

INDIAN CORN (MAIZE) EXPERIMENTS.

New York State, Seasons of 1918 and of 1919.

Experiments in New York State. Experiments in New York State carried on with maize ensilage, or Indian corn, show that whilst the return in value of the increased crop is not excessive owing, no doubt, to the lateness of the fertilizer application, notable crop increases were obtained.

Late Fertilizer Applications Not Generally Advisable.

The late fertilizer application was used in this case advisedly to check up this practice which is followed by many farmers, and which is rather against our general advice as to very late dressings of Nitrate. Earlier applications on corn, we are confident, will prove to be more profitable.

Efficiency of Nitrate Alone.

Among interesting items secured are the yields of protein per acre as tabulated in the following tables. It is notable that the total ash mineral residue per acre removed from the plot on which Nitrate alone was used is less than on the check plot, and that the exhaustion of phosphoric acid, potash and lime was at a lower rate per acre on the Nitrate plot than on the check plot. Notable also is the fact that the rate of yield of protein was lower on the check plot and also on the acid phosphate alone plot than on the Nitrate plot. Protein is, of course, a factor of very high food value for dairy stock.

Use of Nitrate Alone Not Exhaustive of Soil Fertility.

The results speak well for Nitrate *not* exhausting soil fertility as to its mineral essentials. It confirms the idea that soil exhaustion proceeds more rapidly when no fertilizers are used as compared with their rational use.

Reports on Experimental Work on Maize Ensilage.

1918.

Crop — Maize Ensilage.
Variety — Half State Corn; Half Gold Nugget.
Location — Chenango County, New York.
Soil — Bottom land.
Cultivations— Three.
Climate — Short season; high altitude, 1,000 feet.
Weather — Cool; latter part of summer drought.
Date of Application of Fertilizer — July 5, 1918.
Date of Harvesting —September 16, 1918.
Size of Plots— 1/4 acre.
Rate of Application Per Acre — 250 lbs. Nitrate of Soda; 400 lbs. Acid Phosphate.
Fertilizers Used — Nitrate of Soda and Acid Phosphate.
Cost of Fertilizer Per Acre — Plot 1, \$12; plot 2, \$8; plot 3, \$4.

Crop in Pounds Per Acre.

Plot Nos.	Table No. 1	Rate of Application Per Acre	Yields per Plot.	Rate of Crop Yields per Acre.
1.	Nitrate of Soda........ and	250 lbs.	7,120 lbs.	28,480 lbs.
	Acid Phosphate	400 lbs.		
2.	Nitrate alone	250 lbs.	6,610 lbs.	26,440 lbs.
*3.	Acid Phosphate alone...	400 lbs.	6,030 lbs.	24,120 lbs.
4.	Check — nothing	...	6,290 lbs.	25,160 lbs.

Pounds Per Acre of Essential Fertility Removed by Crop.

Plot Nos.	Table No. II	Phosphoric Acid.	Potash.	Nitrogen.
1.	Nitrate of Soda and Acid Phosphate	38.45 lbs.	91.99 lbs.	46.28 lbs.
2.	Nitrate alone	34.64 lbs.	82.76 lbs.	42.97 lbs.
3.	Acid Phosphate alone...	33.29 lbs.	81.53 lbs.	39.20 lbs.
4.	Check — nothing	37.24 lbs.	94.35 lbs.	40.89 lbs.

Pounds Per Acre of Protein and Ash (Minerals) and Lime Removed by Crop.

Plot Nos.	Table No. III	Protein.	Ash.	Lime.
1.	Nitrate of Soda and Acid Phosphate	506.9 lbs.	336.1 lbs.	17.94 lbs.
2.	Nitrate alone	499.7 lbs.	290.8 lbs.	14.81 lbs.
3.	Acid Phosphate alone...	465.5 lbs.	282.2 lbs.	18.09 lbs.
4.	Check — nothing	462.9 lbs.	299.4 lbs.	19.88 lbs.

1919.

Crop — Maize Ensilage.
Variety — Golden Nugget.
Location — Chenango County, New York.
Soil — Clay loam.
Cultivations — Three.
Climate — Temperate; 1,000 feet above sea.
Weather — Cloudy; wet.
Amount of Fertilizer Per Plot — 20, 40 and 80 lbs.
Method of Cultivation — Horse cultivator and by hand hoeing.
Date of Application of Fertilizer — June 5, 1919, for plots 1, 2, 3 and 4; and June 5 and 24 for plots 5 and 6, when corn was 9 inches high.
Date of Harvesting — September 15, 1919.
Size of Plot — 1/10 acre, plots 1, 2, 3 and 4; 1/20 acre, plots 5 and 6.
Rate of Application Per Acre — 200 lbs., 400 lbs. and 600 lbs.
Fertilizers Used — Nitrate of Soda and Acid Phosphate.
Cost of Fertilizer Per Acre — $26.40.
Method of Applying — Broadcast, cultivated in immediately.

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*Acid Phosphate alone appears to have diminished the crop here as it did in the case of our sugar cane in Porto Rico.

Crop in Pounds Per Acre.

Plot Nos. Table No. I	Rate of Application per Acre.	Crop Yields per Plot.	Rate of Crop Yields per Acre.
1. Nitrate of Soda and Acid Phosphate	400	4,180	41,800
2. Nitrate alone	400	4,100	41,000
3. Acid Phosphate alone	400	2,840	28,400
4. Check — nothing	...	2,820	28,200
5. $NaNO_3$ and P_2O_5	200 each June 5, 1919; 200 each June 24, 1919..	1,780	35,600
6. $NaNO_3$ and P_2O_5	200 each June 5, 1919; 400 each June 24, 1919..	2,040	40,800

Pounds Per Acre of Protein and Minerals Removed by Crop.

Plot Nos. Table No. II	Phosphoric Acid.	Potash.	Protein.	Nitrogen.
1. Nitrate of Soda and Acid Phosphate	47.23	95.30	689.7	110.3
2. Nitrate alone	38.06	109.06	471.5	75.4
3. Acid Phosphate alone	56.99	77.25	289.4	46.3
4. Check — nothing	31.58	62.89	377.3	61.1
5. $NaNO_3$ and P_2O_5	47.70	75.83	585.2	93.6
6. $NaNO_3$ and P_2O_5	56.71	102.82	739.7	118.3

Pounds Per Acre of Minerals Removed by Crop.

Plot Nos. Table No. III	Ash.	Lime.
1. Nitrate of Soda and Acid Phosphate	456.9	31.77
2. Nitrate alone	468.6	38.54
3. Acid Phosphate alone	342.2	28.12
4. Check — nothing	293.0	27.35
5. $NaNO_3$ and P_2O_5	408.0	45.57
6. $NaNO_3$ and P_2O_5	472.1	34.68

Pounds Per Acre of Essential Fertilizer Ingredients Added to the Soil in the Fertilizers Used.

1919.

Plot Nos.	Table No. IV	Rate of Application per Acre	Nitrogen	Phosphoric Acid	Potash in Nitrate Used Estimated
1.	Nitrate of Soda..........	400	56	....	8
	and				
	Acid Phosphate	400	....	56	8
2.	Nitrate alone	400	56	....	8
3.	Acid Phosphate alone....	400	....	56	....
4.	Check — nothing	....	....	....	....
5.	$NaNO_3$ and P_2O_5.........	400 each	56	56	8
6.	$NaNO_3$ and P_2O_5.........	600 each	84	84	12

Rate of Profit Per Acre.

The profit per acre as between the application of 400 pounds of acid phosphate alone, and of Nitrate and acid phosphate together shows that the added investment in 400 pounds of Nitrate, which may be estimated at practically fourteen dollars ($14), gave a rate of profit of twenty dollars ($20) per acre, valuing ensilage at present at five dollars ($5) a ton.

Since the rate of yield per acre of the Nitrate and acid phosphate plot was 20.9 tons as against a rate of yield per acre of 14.1 tons for the acid phosphate alone plot,—the value in the first case is placed at one hundred four dollars and fifty cents ($104.50) per acre, and in the latter case at seventy dollars and fifty cents ($70.50) per acre. As the crop increase from the use of 400 pounds of Nitrate is valued at thirty-four dollars ($34), and the cost of the Nitrate at fourteen dollars ($14), a profit at the rate of twenty dollars ($20) per acre is the result, as above stated.

These figures are in general in close agreement with those secured in 1918, and confirm the view that rational fertilizing with Nitrate does not appear to exhaust the soil in the *net* result as much as does doing without fertilizers.

Instructions for Using Nitrate of Soda on Corn.

As soon as the corn is planted in the spring, apply the Nitrate of Soda by broadcasting it evenly over the entire surface of the corn field you are fertilizing, at the rate of 200 pounds per acre, which is equal in bulk to about two bushels.

Our Formula for Corn.

Nitrate alone	200 lbs. per acre
or preferably	
Nitrate	300 " " "
Acid Phosphate	300 " " "

When potash salts can be conveniently obtained we advise the use of fifty pounds of sulphate of potash to the acre every other year.

SMALL FRUITS.

Under this head we treat of blackberries, currants, gooseberries and raspberries. Strawberries are treated separately. All these small fruits are commonly grown in the garden, generally under such conditions that systematic tillage is not practicable. For this reason such plant food essentials as may exist naturally in the soil become available to the uses of the plants very slowly. This is as true of the decomposition of animal or vegetable ammoniates as of phosphates and potashes. Consequently, small fruits in the garden suffer from lack of sufficient plant food. All these plants when planted in gardens are usually set in rows four feet apart, the plants about three feet apart in the rows; about 4,200 plants to an acre. In field culture, blackberries are usually set four feet apart each way.

So far as possible, small fruits should be cultivated in the early spring, and all dead canes removed. Work into the soil along the rows 300 pounds of acid phosphate and 50 pounds of sulphate of potash if obtainable; when the plants are in full leaf, broadcast along the rows 300 pounds of Nitrate of Soda, and work in with a rake. If at any time before August the vines show a tendency to drop leaves, or stop growing, apply more Nitrate. Small

fruits must have a steady, even growth; in most cases unsatisfactory results can be directly traced to irregular feeding of the plants. In field culture, the crop must be tilled quite the same as for corn; in the garden in very dry weather irrigation should be used if possible. The yield per acre is very heavy, and, of course, the plants must be given plant food in proportion.

RASPBERRIES, CURRANTS, GOOSEBERBIES.

Sow broadcast, in the fall, a mixture of 300 pounds of acid or superphosphate and 50 pounds sulphate of potash per acre if obtainable. This can be done, if the rows are four feet apart, by sowing a large handful at every two steps *on each side of the row.* Raspberries and gooseberries should have a small handful, and currants a large handful to each bush. This should be cultivated in, if possible, early in the spring. Sow Nitrate of Soda in the same way. It will pay to put on as much Nitrate as you did acid or superphosphate, but if you do not want to put on so much, use smaller handfuls.

Our Formula for Raspberries and Currants.

Nitrate alone	200 lbs. per acre
or preferably	
Nitrate	300 " " "
Acid Phosphate	300 " " "

When potash salts can be conveniently obtained we advise the use of fifty pounds of sulphate of potash to the acre every other year.

STRAWBERRIES.

This plant requires a moist soil, but not one waterlogged at any time of the year. A light clay loam, or a sandy loam is preferable. There are several methods of cultivation, but the matted row is generally found more profitable than the plan of growing only in hills. While some growers claim that one year's crop is all that should be harvested before ploughing down for potatoes, as a matter of fact the common practice is to keep the bed for

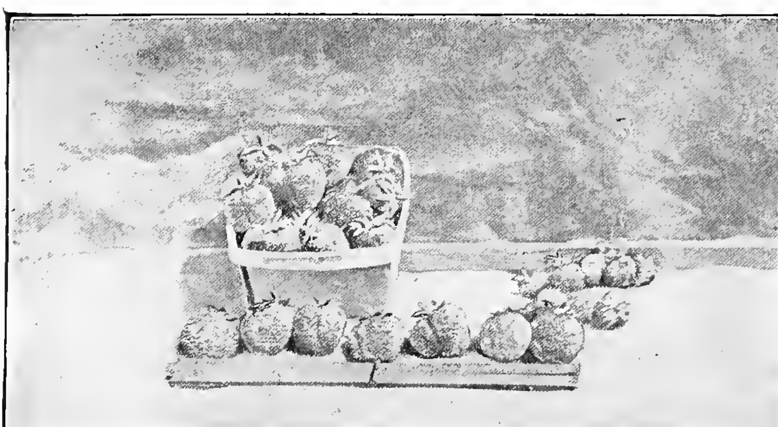
at least two harvests. In selecting plants, care should be exercised to see that pistillate plants are not kept too much by themselves, or the blossoms will prove barren. Farmyard manure should never be used after the plants are set out, as the weed seeds contained therein will give much trouble, especially as the horse hoe is of little use in the beds. Use 200 pounds of acid phosphate, applied broadcast immediately after harvest. In the spring as soon as growth begins broadcast 150 pounds of Nitrate of Soda to the acre. In setting out a new bed, broadcast the fertilizer along the rows and cultivate in, before the plants are out.

On old beds, sow 200 pounds of acid phosphate broadcast in the fall and 150 pounds of Nitrate per acre in the spring.

Our Formula for Strawberries.

Nitrate alone	150 lbs. per acre
or preferably	
Nitrate	200 " " "
Acid Phosphate	200 " " "

When potash salts can be conveniently obtained we advise the use of fifty pounds of sulphate of potash to the acre every other year.



In the basket, and lying on 12-inch rule, 200 lbs. Nitrate of Soda to the acre.

To the right back of rule, no Nitrate.

The experiment was with a field of Bubachs. One plot was given 200 pounds of Nitrate of Soda to the acre when growth began. Another received no Nitrate. On June 3d all the ripe fruit was picked from equal length of rows of each plot. The photograph shows the result.

GRAPES.

Grape vineyards should be located and planted by an expert, and one, too, who has had experience with the locality selected for the site. The treatment of the young plants is a matter of soil and climate, for which there are no general rules. When the vines have reached bearing age, however, their fertilization becomes a very important matter. The new wood must be thoroughly matured to bear next year's fruit, and an excess of ammoniate late in the season not only defeats this object, but also lessens the number of fruit buds.

Instructions for Using Nitrate of Soda on Grapes.

Apply the Nitrate of Soda by broadcasting it evenly over the entire surface of the vineyard you are fertilizing, at the rate of 200 pounds per acre, during the early spring months, preferably just before the vines are in bud.

Our Formula for Grapes.

Nitrate alone	200 lbs. per acre
or preferably	
Nitrate	300 " " "
Acid Phosphate	300 " " "

When potash salts can be conveniently obtained we advise the use of fifty pounds of sulphate of potash to the acre every other year.

GREENHOUSE PLANT FOOD.

For flowering plants in greenhouses, as long as possible before blooming, apply one pound of Nitrate of Soda to 200 square feet of surface. This application is equal to 200 pounds per acre. If used with Acid Phosphate, a larger amount viz: One and one-half pounds of Nitrate of Soda with an equal quantity of Acid Phos-

phate may be used to each 200 square feet of surface, making 300 pounds per acre, provided excessive quantities of barnyard manure have not been used. It is important to thoroughly work these fertilizers into the soil.

The use of rotted stable manure as a source of greenhouse plant food has been the custom for many years. Manure, however, supplies its plant food very irregularly and the Nitrogen which it contains is not nitrated, hence for forcing plants it cannot be fully relied upon. It should be supplemented by the use of commercial fertilizers such as Nitrate of Soda and acid phosphate.

For Plants in Pots.

Water once every four days, during early active growth, with a solution of one-half an ounce of Nitrate of Soda to one gallon of water — avoid wetting the foliage. This will produce dark green color in the leaves, which, when obtained, indicates that for this most important period, a sufficient amount of Nitrate of Soda has been used. Do not put dry Nitrate on wet foliage

For young fruit trees in the nursery, from one-quarter to one pound of Nitrate of Soda per acre may be used, according to age. It is important in this case that the fertilizer should be thoroughly worked into the soil.

LAWNS AND GOLF LINKS.

Good lawns are simply a matter of care and rational treatment. If the soil is very light, top-dress liberally with clay and work into the sand. In all cases the soil must be thoroughly fined and made smooth, as the seed, being very small, requires a fine seed bed. In the South, seed to Bermuda grass or Kentucky blue grass; in the North, the latter is also a good lawn grass, but perhaps a little less desirable than Rhode Island bent grass (Agrostis canina). Avoid mixtures, as they give an irregularly colored lawn under stress of drouth, or early frosts, or maturity.. For Rhode Island bent grass use 50 pounds of seed per acre, Kentucky blue grass 40 to 45 pounds,

and for Bermuda grass 15 pounds. If for any reason the soil cannot be properly prepared, pulverize the fertilizer very fine indeed. The grass should be mowed regularly and the clippings removed until nearly midsummer when they are best left on the soil as a mulch. For a good lawn, broadcast per acre in the spring 50 pounds of sulphate of potash, 200 pounds of acid phosphate and 200 pounds of Nitrate of Soda. Lawns are very different from field crops as they are not called upon to mature growth in the line of seed productions, and they may safely be given applications of Nitrate whenever the sickly green color of the grass appears, which shows that digestible or nitrated ammonia is the plant food needed. These applications of plant food must be continued each year without fail, and all bare or partly bare spots well raked down and reseeded. If absolutely bare, these spots should be deeply spaded. On very heavy clay soils, and in low situations, a drainage system must be established.

Instructions for Using Nitrate of Soda on Meadows, Lawns and Golf Links.

As soon as the frost leaves the ground in the spring, apply the Nitrate of Soda by broadcasting it evenly, by hand, or by machine, over the entire surface of the lawn, or meadow you are fertilizing, at the rate of 100 pounds per acre.

Frequent rolling is of great advantage, as well as frequent raking. Every lawn in the spring should be subjected to a searching inspection for weeds. Early spring is the time for the heavy annual top-dressing of fertilizers.

Two or three weeks after the application of fertilizers, a mixture of lawn grasses may be sown and covered with a thin layer of finely sifted soil and then rolled down. Rolling should not be continually in one direction, but should be changed.

If young grasses are growing amongst the old, it will be an advantage to keep the lawn closely cut. By this practice roots are strengthened and the density of the

turf increased. In sowing lawn seed, sow half the quantity going north and south, and half east and west.

Grass which has become brown or yellow may be watered or treated with Nitrate of Soda and the green color thus restored. Lawns may safely be given applications of Nitrate whenever the sickly green color of the grass appears, as this shows that Nitrogen is the food needed. Finely sifted soil obtained from decayed leaves is the best treatment for lawns to provide them with humus.

Our Formula for Meadows, Lawns and Golf Links.

Nitrate alone	100 lbs. per acre
or preferably	
Nitrate	200 " " "
Acid Phosphate	200 " " "

When potash salts can be conveniently obtained we advise the use of fifty pounds of sulphate of potash to the acre every other year.

FLOWERS.

Every gardener (of vegetables or flowers) should have at hand, all through the season, a bag or box of Nitrate of Soda, to be broadcast on any and every crop that grows in the garden. The need for Nitrogen is indicated by the pale green color of foliage and slow growth. It is quite easy to be too liberal in using Nitrate; 200 pounds of Nitrate per acre, if used alone, is the quantity to be applied at any one time. One pound of it would give about 30 heaping teaspoonfuls. So 1 to 1½ such spoonfuls to a square yard, or 3 feet along a row that is 3 feet wide, would be about 100 pounds per acre. The quantity, however, may be larger where the plants — such as cabbage — are half grown and in good condition to grow.

Nitrate of Soda is an ideal fertilizer for all kinds of flowering plants, especially roses. It is, as you know, neat and cleanly and harmless (not acid, nor caustic), and every woman who cultivates vegetables and flowers should keep it on hand, to be used as occasion shall demand at the rate of one-half to one teaspoonful to the square yard, or one rose bush.

Fertilizer Experiments with Fuchsias.

Phosphoric Acid and Potash without Nitrate of Soda. | Phosphoric Acid and Potash with $2\frac{1}{4}$ oz. Nitrate of Soda.

Instructions for Using Nitrate of Soda on Flowers.

Apply the Nitrate of Soda by broadcasting it evenly over the entire surface of the garden you are fertilizing, at the rate of 200 pounds per acre, before you sow your seeds in the garden and before you set out your plants. It may be applied later by hand between the rows at the same rate if you find the earlier time inconvenient.

Our Formula for Flowers.

Nitrate alone	200 lbs. per acre
or preferably	
Nitrate	300 " " "
Acid Phosphate	300 " " "

When potash salts can be conveniently obtained we advise the use of fifty pounds of sulphate of potash to the acre every other year.

Fertilizer Experiments with Chrysanthemums.

Phosphoric Acid and Potash. Phosphoric Acid and Potash with $1\frac{1}{8}$ oz. Nitrate of Soda.

MARKET GARDENING WITH NITRATE.

Successful Results in an Unfavorable Growing Season.

Asparagus.

The bed was twenty years old, and had been neglected. As soon as workable, it was disc-harrowed, and later smooth-harrowed with an Acme harrow. Nitrate of Soda was applied to the plots early in April. It was sown directly over the rows and well worked into the soil.

The experiment comprised three plots, two fertilized with Nitrate of Soda, and one without Nitrate, plot 3. Plots 1 and 2, treated with the Nitrate, produced marketable stalks ten days in advance of plot 3, a very material advantage in obtaining the high prices of an early market. The results were as follows, in bunches per acre:

Plot and Fertilizer	Bunches per acre	Gain
3. No Nitrate	560	——
2. 200 lbs. Nitrate............	680	120
1. 400 lbs. Nitrate............	840	280

Celery.

Extraordinary Returns on Celery.

Crisp stalks of rich nutty flavor are a matter of rapid, unchecked growth, and plant food must be present in unstinted quantity, as well as in the most quickly available form, the best example of which is Nitrate of Soda. The soil was plowed early in May, and subsoiled, thoroughly breaking the soil to a depth of 10 inches. Thirty bushels of slacked lime per acre was broadcasted immediately after plowing, followed by a dressing of 20 tons of stable manure, all well worked into the soil. Plants were set May 10th. The tract was portioned into three plots for experimental purposes; plot 1 received 675 pounds of Nitrate of Soda per acre, plot 2 received 475 pounds and plot 3 none.

Plot 1 was ready for market July 6th, and was all off by the 10th. Plot 2 was ready for market July 11th and

was all harvested by the 14th. Plot 3 was practically a failure and was not harvested. Plot 1, being first in the market, had the advantage of the best prices.

Instructions for Using Nitrate of Soda on Asparagus and Celery.

(1) Apply the Nitrate of Soda at the rate of 200 pounds per acre by broadcasting it evenly along the rows, shortly after the plants are set out. (2) A similar application may be made four weeks later. Cultivate after each application.

675 lbs. Nitrate of Soda to the acre. 475 lbs. Nitrate of Soda to the acre. No Nitrate.

Our Formula for Asparagus and Celery.

Nitrate alone	200 lbs. per acre
or preferably	
Nitrate	300 " " "
Acid Phosphate	300 " " "

When potash salts can be conveniently obtained we advise the use of fifty pounds of sulphate of potash to the acre every other year.

Beets.

Table Beets Grown on Nitrate Were Ready for Market 16 Days Ahead of Unfertilized Plots.

The crop must be forced to quick growth in order to obtain tender, crisp vegetables, readily salable and at good prices. Nitrate of Soda was compared with unfertilized soil, with the result that on the nitrated plots marketable beets were pulled 56 days from seeding; the unfertilized plot required 72 days to produce marketable vegetables. Nitrate of Soda was applied at the rate of 500 pounds per acre.

Table Beets.

500 lbs. Nitrate of Soda to the acre. No Nitrate.

Instructions for Using Nitrate of Soda on Sugar Beets.

Apply the Nitrate of Soda by broadcasting it evenly, by machine or by hand, over the entire surface of the sugar beet field you are fertilizing, at the rate of 200 pounds per acre before or soon after planting. Two hundred pounds of Nitrate is equal in bulk to about two bushels.

Our Formula for Sugar Beets.

Nitrate alone	200 lbs.	per	acre	
or preferably				
Nitrate	300	"	"	"
Acid Phosphate	300	"	"	"

When potash salts can be conveniently obtained we advise the use of fifty pounds of sulphate of potash to the acre every other year.

Early Cabbage.

How a Crop Was Saved from Total Failure.

The cabbage plots were thoroughly worked up, and planted to Henderson's Early Spring Variety. Part of the soil was treated with Nitrate of Soda at the rate of 575 pounds per acre. The part of the plot not treated with Nitrate of Soda was a failure.

Cabbage and Cauliflower.

Cabbage requires a deep mellow soil, rich in plant food. As the soil is thoroughly fined in the spring, there should be incorporated with it by rows, corresponding to the rows of plants, about 1,500 pounds of fertilizer per acre. For early cabbage set close together; it will pay to sow the fertilizers broadcast over the whole ground and work them in before setting out the plants. *If the land has been heavily manured for a number of years Nitrate of Soda alone may do as much good as the mixture.* In this case, the Nitrate may be used after the plants are set out — a teaspoonful to a plant.

For late cabbage, set 2½ to 3 feet apart each way. It is a good plan to apply the fertilizers after the plants are set out.

No Nitrate.

575 lbs. Nitrate of Soda to the acre.

After the plants have set and have rooted, say a week from setting, apply along the rows a top-dressing of 200 pounds of Nitrate of Soda per acre and work into the soil with a fine toothed horse hoe; the soil must be kept loose to a depth of at least two inches, and consequently there will be no extra labor in working this fertilizer into the soil. Some three weeks later incorporate in the same manner into the soil 300 to 400 pounds of Nitrate of Soda. *Soil Nitration* cannot be depended on under any circumstances for supplying enough natural Nitrate for cabbage. Nitrate of Soda is the only pre-digested nitrate in the market, is an absolute necessity for early cabbage, and should be used liberally. This crop should not follow itself more than twice, as by so doing there is no little danger of serious disease to the crop.

Cauliflower.

Nitrated Plot Yields Profit. Non-Nitrated a Total Loss.

The cauliflower plot was treated exactly the same as the cabbage plot. The plants were set on April 26th. The nitrated plot matured 80 per cent. of the plants set early in the season. Cutting began on July 1st, when high prices ruled. The plot on which no Nitrate was used failed to mature a single plant so that no comparative figures can be given. All the profit in the nitrated plot was gain over the non-nitrated plot.

Late Carrots.

No Nitrate.

300 lbs. Nitrate of Soda to the acre.

Carrots.

All plots were fertilized with acid phosphate and potash.

I	II	III	IV
No. Nitrate.	½ gr. Nitrate.	3 gr. Nitrate of Soda.	4½ gr. Nitrate of Soda.

The carrots were planted April 21st and treated the same as the beets. The nitrated plot yielded matured carrots June 27th. Crop was first pulled from the non-nitrated plot about the middle of September. Carrots from the nitrated plot sold for from 5 to 8 cents a bunch more than those from the non-nitrated plot.

Instructions for Using Nitrate of Soda on Cabbage and Carrots.

Apply the Nitrate of Soda by broadcasting it evenly over the entire surface of the vegetable field you are fer-

tilizing, at the rate of 300 pounds per acre, before seeding or planting, or transplanting.

Our Formula for Cabbage and Carrots.

Nitrate alone	300 lbs. per acre
or preferably	
Nitrate	400 " " "
Acid Phosphate	400 " " "

When potash salts can be conveniently obtained we advise the use of fifty pounds of sulphate of potash to the acre every other year.

Cucumbers.

Plants were set in box frames May 4th. The frames were well filled with rotted manure, and were banked as a protection against late frosts. A portion of the field was treated with Nitrate of Soda; on May 10th each plant was given a quart of a solution made by dissolving three pounds of Nitrate of Soda in 50 gallons of water. Several applications were made on the experimental plot, making a total of 165 pounds of Nitrate of Soda per acre. On June 27th the experimental plot was setting fruit rapidly, while the plot without nitrate was just coming into bloom. The nitrated plot was given on June 29th a quart of a solution made by dissolving two ounces of Nitrate of Soda in a gallon of water; and this application was repeated July 3d, 7th, 15th. 24th, and August 8th. This practically doubled the Nitrate application.

Gain in Time in This Crop Very Remarkable, Two Weeks in Advance.

The first picking on the nitrated plot was made July 1st, on the non-nitrated plot July 22d, when prices were at the lowest point. After the early market season was over, the vines were treated for pickling cucumbers, the nitrated plot receiving Nitrate dissolved in water as before and later, two applications of a quart each, containing half an ounce per gallon. The result was that the vines continued bearing until cut down by frost. The estimated yields were as follows: Nitrated plot, per acre, 6,739 dozen, plot without Nitrate gave per acre 948 dozen.

324 lbs. Nitrate of Soda to the acre.

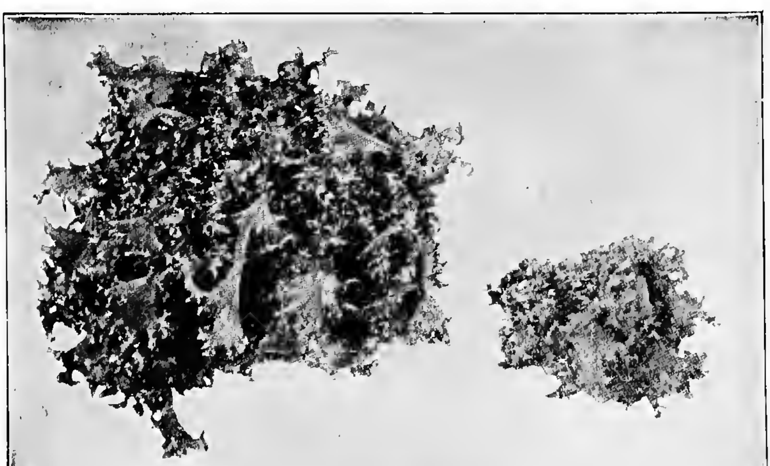
No Nitrate.

Sweet Corn.

The crop was planted on rather poor soil. Seed was planted May 4th, and the cultivators started May 12th. A portion of the field was selected for experiment, and on this 75 pounds of Nitrate of Soda per acre was applied May 20th, drilled close to the row. A second application of the same amount was made May 26th, and on June 5th a third application. On June 17th, 100 pounds per acre was applied and cultivated into the soil. The total Nitrate applied to the experimental plot amounted to 325 pounds per acre. The nitrated plot ripened corn five days ahead of the non-nitrated portion, and *produced* 994 *dozen* ears against 623 *dozen from an acre not treated* with Nitrate of Soda. The Nitrated crop, being earlier in the market, brought better prices.

Endive.

The photograph of average specimens from a plot which received 300 pounds of Nitrate of Soda to the acre, and from one which received none, shows the beneficial result obtained from the use of Nitrate of Soda.



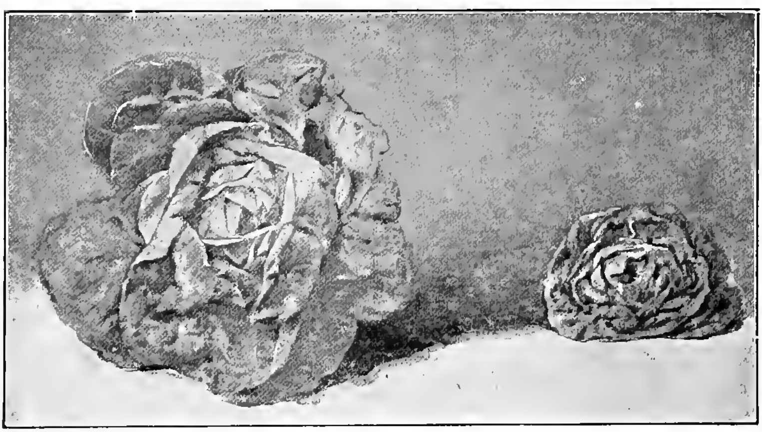
300 lbs. Nitrate of Soda to the acre. No Nitrate.

Egg-Plant.

The plants were set in the usual manner, part of the tract being treated with Nitrate of Soda at the rate of 475 pounds per acre to observe the practical value of the Nitrate for forcing. Before setting, the plants were given a light application of Nitrate in solution. June 1st, 150 pounds was applied, on the tenth this was repeated and on June 22d a third application was made. The nitrated plot produced marketable fruit July 5th, the non-nitrated plot did not reach the market until July 26th. *The nitrated plot produced per acre* 33,894 *fruits, all of good quality; the non-nitrated plot produced only* 8,712 *fruits per acre.*

Early Lettuce.

The plants were started in the hot house, and pricked into cold frames; April 26th they were set in the field.



750 lbs. Nitrate of Soda to the acre in 5 applications. — No Nitrate.

The Nitrate applications on the experiment plot were per acre as follows: April 29th, 100 pounds; May 4th, 150 pounds; May 12th, 200 pounds; May 18th, 200 pounds; May 23d, 100 pounds; a total of 750 pounds per acre.

The nitrated plot was first cut May 26th, and at this time the non-nitrated plot was just beginning to curl a few leaves towards the heart for heading. Approximately, *the nitrated plot produced per acre,* 1,724 *dozen heads,* and being early to market brought a good price. *On the non-nitrated plot only about* 4 *per cent. of the plants headed, and these reached the market three weeks late.* Without the Nitrate dressing the crop was a failure.

Musk Melons.

325 lbs. Nitrate of Soda to the acre in 15 applications. No Nitrate.

Musk melons were transplanted from the hot house on May 4th; 325 pounds Nitrate per acre was applied on fifteen occasions, about 6 days apart, between May 10th and August 8th. The first ripe fruit was picked July 19th, 88 days after planting seed and 76 days after transplanting from hot house. The yield was at the rate of 9,680 melons per acre, none of which sold for less than 5 cents, and many for 10 cents. The vines on the non-nitrated plot gave but very small return and did not give any return for the labor spent on them.

Onions.

The soil was in bad condition, and was liberally limed. Seeding was completed April 15th, and the plants were rapidly breaking ground by the 28th. The tract was divided into three plots; plot 1 received 675 pounds of Nitrate of Soda in six applications at intervals of a week

675 lbs. of Nitrate of Soda to the acre in 6 applications. 375 lbs. of Nitrate of Soda to the acre in 4 applications. No Nitrate.

or 10 days; plot 2 received 375 pounds in four applications; plot 3 was not treated with Nitrate. The nitrated plots seemed least affected by the exceptionally dry weather, but the crop on all the plots was no doubt reduced by the unfavorable conditions. The following table gives the results by plots, *computed to an acre* basis:

	Nitrate 675 lbs.	Nitrate 375 lbs.	No Nitrate
Total yield	756 bu.	482 bu.	127 bu.
Per cent. scullions	1.5	1.7	19.0

The results show very clearly the value of the Nitrate applications.

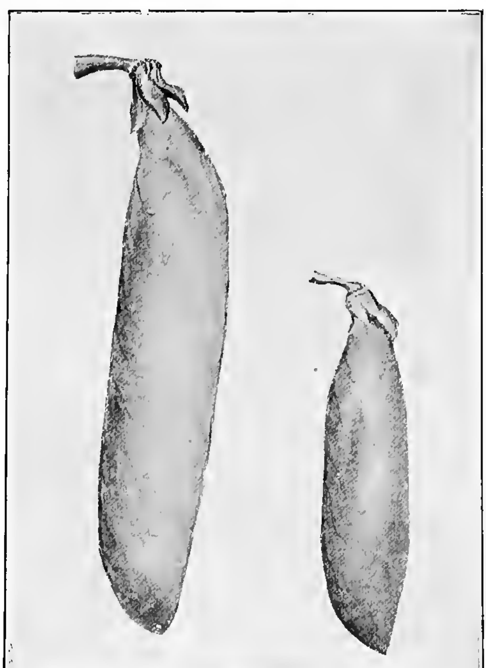
Instructions for Using Nitrate of Soda on Onions.

As soon as the onions are up in the spring, or before seeding, apply the Nitrate of Soda by broadcasting it evenly, by hand or by machine, over the entire surface of the onion field you are fertilizing, at the rate of 200 pounds per acre.

Our Formula for Onions.

Nitrate alone	200 lbs. per acre
or preferably	
Nitrate	300 " " "
Acid Phosphate	300 " " "

When potash salts can be conveniently obtained we advise the use of fifty pounds of sulphate of potash to the acre every other year.



300 lbs Nitrate of Soda to acre. No Nitrate

Early Peas.

This crop was planted under the same conditions and in like manner to snap beans; 300 pounds of Nitrate of Soda per acre was applied to the experiment plots. Two varieties were planted, early and late. The results were:

	Early		Late	
	Nitrate	Nothing	Nitrate	Nothing
Date planted	April 15.	April 15.	May 1.	May 1.
First picking	June 8.	June 17.	June 29.	July 4.
Gain to market..........	9 days.	———	5 days.	———
Period of bearing.......	11 days.	8 days.	10 days.	6 days.
Crop on first picking....	55 p. c.	40 p. c.	57 p. c.	38 p. c.
Total yield (p. c.)........	165	100	168	100

The season was very unfavorable for this crop, yet the results show that the Nitrate made a powerful effort to offset this disadvantage. The earliness to market in this case is as pronounced as in the other garden crops, and is one of the most profitable factors in the use of Nitrate of Soda. The lengthening of the bearing period is an added advantage.

Peppers.

Nitrate Doubles Yield.

Pepper plants were transplanted May 22nd, when Nitrate of Soda at the rate of 100 pounds to the acre was applied, followed by a second application of 200 pounds on May 31st, and others of 100 pounds each on June 7th and June 19th. The yield from the plot treated with 500 pounds of Nitrate was at the rate of 14,620 dozen per acre, and pulling was begun June 30th. The plot without Nitrate treatment yielded at the rate of 7,432 dozen per acre and pulling did not begin till August 7th, 38 days later.

Early Potatoes.

Ploughing was finished the second week in April, and the plot limed at the rate of 35 bushels per acre. Furrows were opened three feet apart, and 750 pounds per acre of a high-grade fertilizer worked into the rows.

May 1st the potatoes were breaking ground, and 100 pounds of Nitrate of Soda per acre was applied on the experiment plot. On the 11th, 200 pounds of Nitrate was applied, and on the 29th, 150 pounds more was cultivated in with a horse-hoe. The total Nitrate application per acre was 450 pounds. The nitrated plot was harvested July 6th; the plot not treated with Nitrate was dug July 17th, 11 days later. The nitrated plot produced per acre 19 bushels unmarketable tubers, the non-nitrated plot 46 bushels. The total crop marketable was 297 bushels for Nitrate, and 92 bushels for non-nitrated plot.

450 lbs. Nitrate of Soda to the acre in 3 applications. No Nitrate.

Late Potatoes.

Conditions same as in the case of early potatoes, except the Nitrate of Soda was used at the rate of 500 pounds per acre. The crop of marketable tubers, per acre on the nitrated plots, amounted to 374 *bushels;* on the non-nitrated plot the yield amounted to 231 *bushels* marketable tubers. The gain for Nitrate of Soda was 143 bushels, or nearly 62 per cent. increase.

Yield without Nitrate. Yield with Nitrate.

Instructions for Using Nitrate of Soda on Potatoes.

As soon as the potatoes are up in the spring, or just before planting, apply the Nitrate of Soda by broadcasting it evenly, by hand or by machine, over the entire surface of the potato field you are fertilizing, at the rate of 200 pounds per acre, or apply it broadcast prior to planting.

Our Formula for Potatoes.

Nitrate alone	200	lbs.	per	acre
or preferably				
Nitrate	400	"	"	"
Acid Phosphate	400	"	"	"

When potash salts can be conveniently obtained we advise the use of fifty pounds of sulphate of potash to the acre every other year.

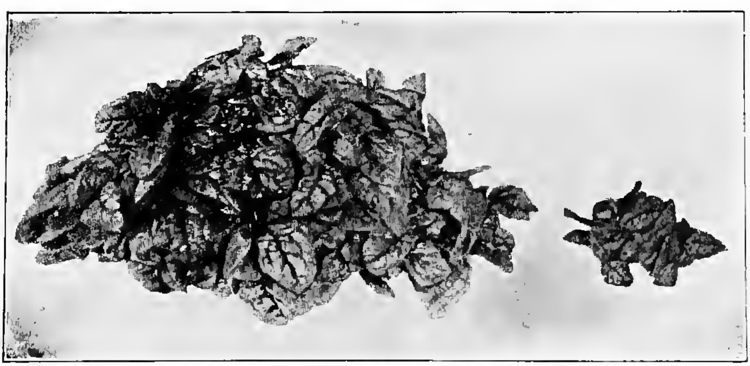
Radishes.

Quick Yield Procured by Nitrate.

The ground in which radishes were planted was newly turned timothy sod, not fertilized for ten years. Seed was drilled in April 12th. Nitrate of Soda, 75 pounds to the acre, was applied April 20th, followed by an application of 150 pounds a week later. Radishes on the nitrated plot matured evenly and were marketed on May 15th at five cents a bunch retail, the wholesale price ranging from $2 to $2.50 per hundred. The radishes on the non-nitrated plot matured unevenly and when ready the market was glutted.

Late Spinach.

The ground used for this experiment, though under cultivation for generations, had never been fertilized. Nitrate of Soda at the rate of 350 pounds to the acre was used in two applications. The photograph of the product of an equal space of row from the nitrated and non-nitrated plots tells the result.



350 lbs. Nitrate of Soda to the acre in two applications. — No Nitrate.

Early Tomatoes.

With this crop the object is to mature quickly, rather than to obtain a heavy acre yield; one basket of early

tomatoes at $1.25 *is worth more than* 15 *baskets later in the season, when the price is about* 8 *cents per basket.* The plants to be used on the nitrated plot were treated with a diluted solution of Nitrate four separate times. Plants were field set May 17, and given six applications of Nitrate of Soda; first, 100 pounds per acre soon after setting out; second, third and fourth of 75 pounds each; and fifth and sixth of 50 pounds each — in all, about 425 pounds per acre. The results were:

	Nitrate	No Nitrate
Plants set out in field	May 17.	May 17.
First picking	June 30.	July 19.
Days, setting to first picking	43	62
Crop at $1.00 and upward per basket	40 per cent.	———
" .75 " "	30 "	10 per cent.
" .50 " "	20 "	15 "
" .30 " "	10 "	20 "
" .25 " "	———	25 "
" .15 " "	———	15 "
" .08 " "	———	15 "
Estimated yield per acre, baskets	500	600
Gross receipts	$377 50	$190 20
Cost of Nitrate of Soda and application	10 35	———
Net receipts	367 15	190 20
Gain per acre for Nitrate	176 95	———

Instructions for Using Nitrate of Soda on Tomatoes.

Apply the Nitrate of Soda by broadcasting it evenly over the entire surface of the vegetable field you are fertilizing, at the rate of 200 pounds per acre, before seeding, or planting, or transplanting.

Our Formula for Tomatoes.

Nitrate alone	200 lbs. per acre.
or preferably	
Nitrate	300 " " "
Acid Phosphate	300 " " "

When potash salts can be conveniently obtained we advise the use of fifty pounds of sulphate of potash to the acre every other year

OBSERVATIONS UPON THE LEACHING OF SOLUBLE FERTILIZER SALTS FROM CRANBERRY SOILS.

BY JOHN H. VOORHEES,

Former Assistant in Charge Cranberry Investigations, N. J. Experiment Station.

In the spring of 1913 the author was detailed by the New Jersey Experiment Station to study the fertilizer requirements of the cranberry. After a survey of the field it was decided to locate the experimental work upon bogs owned and operated by practical growers. Headquarters for this work were located at the bogs of J. J. White, Incorp., situated about three miles northeast of Hanover farms on the P. R. R. in Burlington county. A rather complete series of plots was planned including the separate use of four sources of Nitrogen,— Nitrate of Soda, ammonium sulphate, dried blood 12 per cent., and cotton-seed meal; four sources of phosphoric acid,— acid phosphate, basic slag, phosphate rock and steamed bone; and three sources of potash,— muriate, sulphate and kainit. These materials were not only used separately, but also in complete mixtures in which ammonium sulphate, acid phosphate and muriate of potash were used as constant factors. In each case the fertilized plots received either two pounds of Nitrogen, four of phosphoric acid, or five of potash, and in the case of complete mixtures all of the above quantities were used.

On the bogs of J. J. White the series of plots was laid out in three distinct types of soil; the Savannah, a pure sand mixed with more or less organic matter, deep mud, and deep mud underlaid with iron ore. Wherever possible the plots were made one-twentieth acre in size, one rod wide and eight rods long. (Details of the plan of experiment may be found in 1913 Report, N. J. Agricultural Experiment Station, pages 384–488.)

On June 6, 1913, the first application of fertilizer was made to the plots in these series and observations of the effect of added plant food have been extremely interesting. One occurrence brings out clearly how little an

abundance of water affected the lateral movement of soil moisture and leaching of plant food from the soil stores.

On the nights of June 9th and 10th danger of severe frost caused the proprietors to flow the bogs for protection. The series of plots located in the deep mud and iron ore soils (so-called) were completely flooded to a depth varying from a few inches to a foot. The Savannah plots, even though located in the same bogs, were on a higher level and the water only covered one end of the plots, about one-half of each. At first thought it would appear that the lateral movement of the soil water would carry the plant food, especially the soluble salts, Nitrate of Soda, ammonium sulphate, and the potash salts, from one plot to another, and that there would be considerable leaching of plant food into the drainage water, because the water is drawn through the soil into the ditches on its way out; but subsequent observations extending through the remainder of the year showed a distinct line of markation between the fertilized plots and the check plots adjoining. The increased vine growth causing this distinct markation became clearly defined, first with Nitrate of Soda, then ammonium sulphate, and so on through the list of plots, showing more clearly upon the plots which received complete mixtures.

This condition was more particularly true on the "Savannah" soils, and it might be added that yields were greatly increased. (Record of yields may be found in 1914 Report of N. J. Agric. Experiment Station or Proceedings 45th Annual Meeting American Cranberry Growers' Association.) Upon the deep mud and iron ore plots the differences and lines of markation were distinguishable but not so clearly defined.

After three years of observation and experience, both experimental and practical, the author is convinced that the loss from leaching is so negligible that he feels no hesitancy in advising growers to apply fertilizers composed of Nitrate of Soda, acid phosphate and muriate of potash as soon as the winter water is drawn from the bogs, about May 20th, before the reflow for insect con-

trol, which is a customary practice about the second week in June, and before any flowing which might be necessitated by danger of frost.

NITRATE AS FERTILIZER.

What It Did For an Acre of Sugar Cane in Porto Rico.

Abstract from *Facts About Sugar, September* 7, 1918.

(*The results of an interesting experiment conducted at Central Aguirre, Porto Rico, during the season* 1917–18, *to check up the relative values of Nitrate of Soda, of Acid Phosphate, and of a mixture of the two, as fertilizer for sugar cane, are described in the following article. The accompanying illustrations and table show the striking results obtained from the use of the Nitrate.*—ED.)

An Instructive Demonstration.

A recent experiment conducted at Margarita field, Hacienda Carmen of Central Aguirre, Porto Rico, forcibly brings out the gain in sugar yield, with the accompanying higher financial return resulting, when Nitrate of Soda and acid phosphate were used, compared with the returns when acid phophate was used alone.

The test was made to determine the relative efficiency of acid phosphate — which is the main constituent of the ordinary brands of mixed fertilizer — as compared with Nitrate of Soda.

The cane was grown on adjoining one-acre plots. Applications of the fertilizer materials were made on July 23, 1917, and the cane was cut on May 27, 1918. On one plot 400 pounds of acid phosphate was applied; on a second 400 pounds each of acid phosphate and Nitrate of Soda; on a third, Nitrate of Soda alone, and on the fourth, a check plot, no fertilizer was used. The results obtained are shown in the following table:

Confirms Hawaiian Practice.

Acre Plots	Sucrose, per cent	Purity per cent	Cane yield tons	Sugar yield tons
1. Acid Phosphate	18.09	92.50	24.96	3.2
2. Nitrate of Soda and Acid Phosphate	17.38	91.50	38.00	4.7
3. Nitrate of Soda alone.........	16.45	89.20	41.50	4.7
4. Check plot — no fertilizer......	17.55	91.40	30.73	3.8

Fertilized with 400 lbs. Nitrate of Soda per acre.
Yield: 9,600 lbs. Sugar per acre (30 bags).

Fertilized with 400 lbs. Acid Phosphate per acre.
Yield: 6,400 lbs. Sugar per acre (20 bags).

Fertilized with 400 lbs. Nitrate of Soda per acre.
Yield: 9,600 lbs. Sugar per acre (30 bags).

Check Plot — No Fertilizer.
Yield: 7,680 lbs. Sugar per acre (24 bags).

These figures speak for themselves. It is interesting to note that the $16 worth of Nitrate used alone produced an increase of 16.54 tons of cane, yielding 1.5 tons of sugar, over the acid phosphate plot, which, in terms of cash, represented an increased market value of $138. In view of the stress laid so frequently in the past upon the use of the superphosphate variety of mixes, the sources of Nitrogen in such brands being as a rule entirely unknown to the users, the above experiment is illuminating. This experiment substantially and emphatically confirms Hawaiian results and fully endorses Hawaiian sugar cane practice.

GRASS GROWING FOR PROFIT.

Timothy and related grasses feed heavily on Nitrogen; they are able to transform it completely into wholesome and digestible animal food. When full rations of plant food are present a good crop of grass will remove about the equivalent of the active fertilizer ingredients of 200 pounds of Nitrate of Soda, and 200 pounds of acid phosphate. These amounts per acre are recommended to be broadcasted on old grass lands where intensive fertilization is well understood and practiced. Grass lands get sour easily, especially when old, and when they do, one ton of slaked lime per acre should be harrowed in before seeding down anew. For the best results the seeding should be done before September, and the above-mentioned ration should be used as a dressing the following spring, soon after the grass begins to show growth.

If all the conditions are favorable, from three to five tons of clean barn-cured hay, free from weeds, may reasonably be expected. When grass crops are heavy and run as high as 4½ tons per acre field-cured, it is safe to allow 20 per cent. shrinkage in weight for seasoning and drying down to a barn-cured basis. Nitrate of Soda, the chief constituent of the prescribed ration, insures early growth and enables it to get ahead of all weeds, and the crop then feeds economically and fully on the other

manurial constituents present in the fertilizer mentioned in the formula and present in the soil.

When clean No. 1 hay sells above $16 per ton the financial results are very satisfactory. Nitrate can sometimes be used alone for a season or two and at very great profit, but a full grass ration is better in the long run. Generally speaking, 100 pounds of Nitrate, if used under proper conditions, will produce an increase of from 1,000 to 1,200 pounds of barn-cured, clean timothy hay, the value of which averages from $8 to $10 and upwards. Compared with the value of the increased hay crop, it pays well to use Nitrate liberally on grass lands.

Making Two Blades of Grass Grow Where One Blade Grew Before.

Grass is a responsive crop, and the part played by chemical fertilizers, as proven in Rhode Island, shows the striking effect of Nitrate on yields and feeding quality.

Since all the other fertilizers were alike for the three plots and had been for many years, and since the general character of the soil and the treatments the plots had received were uniform, any differences must be ascribed to the influence of the varying quantities of Nitrate of Soda. These differences, so far as they are shown by the weights of the crops for four years are given in brief below:

Yield of Cured Hay Under Different Rates of Nitrogenous Fertilization.

	Yield of Cured Hay				
Nitrate of Soda Applied	1899, Lbs.	1900, Lbs.	1901, Lbs.	1902, Lbs.	Average Yields in Tons
None	5,075	4,000	3,290	2,950	1.9
150 lbs. per acre*...	6,300	5,600	5,550	4,850	2.8
450 lbs. per acre*...	6,913	8,200	9,390	8,200	4.1

What the Figures Show. These figures show a uniform, consistent and marked advantage from the use of Nitrate of Soda; and the effect of its absence is shown by the steady decline of the yields on the *no*-Nitrate plot from year to

*Amount slightly reduced in 1901 and 1902.

1. Product of one square foot of ground in field yielding over three tons per acre of cured timothy hay fertilized with Nitrate of Soda.

2. Product of one square foot of ground in adjoining field (not fertilized with Nitrate of Soda) yielding one ton per acre of cured hay.

Highland Experimental Farms, New York.

year. In each year the use of 150 pounds of Nitrate gave increased yields over the plot without Nitrogen, the gain varying from 1,200 to almost 2,300 pounds, an average gain of about seven-eighths of a ton of hay. Three times this amount of Nitrate did not, of course, give three times as much hay, but it so materially increased the yield as to show that it was all used to good advantage except, perhaps, in the second year. This was an exceptionally dry year and but one crop could be cut. The advantage from the Nitrate showed strikingly in the production of a rapid and luxurious early growth while moisture was still available. This supply of readily soluble food comes just when it is most needed, since the natural change of unavailable forms of Nitrogen in the soil to the soluble Nitrates proceeds very slowly during the cool, moist weather of spring. The full ration of Nitrogen, 450 pounds of Nitrate, more than doubled the yield of hay over that produced on the no-Nitrate plot in 1900 and in the next two years it nearly tripled the yield. The average increase over the 150-pound plot was one and three-tenths tons and over the plot without Nitrogen was two and five-eighths tons.

Effect on Quality of Hay.

How Nitrate Improves the Quality of the Hay.

Almost as marked, and certainly more surprising and unexpected, was the effect of the Nitrate upon the quality of the hay produced.

The hay from the plots during the first season was of such diverse character that different ton values had to be placed upon it in estimating the profit from the use of fertilizers. That from the no-Nitrate plot, since it contained so much clover at both cuttings, was worth less than that on the plot receiving the full ration of Nitrate.

But the reduction in the percentage of clover was not the only benefit to the quality of the hay. The Nitrate also decreased the proportion of red top as compared with the finer timothy. This tendency was noticed in the second

Types of Characteristic Rock Shattering (1).

Types of Characteristic Rock Shattering (2).

Types of Characteristic Rock Shattering (3).

year, when a count of the stalks on selected equal and typical areas showed 13 per cent. of timothy on the 150-pound plot, and 44 per cent. on the 450-pound plot. In the third year the percentages of timothy were 39 per cent. and 67 per cent., respectively, and in the fourth year the differences were even more marked.

An Alkaline Soil Necessary for Grass.

Timothy is a grass which will not tolerate an acid soil, and it is probable that the liming given these plots in 1897 did not make them as "sweet" as would have been best for this crop. Now, when Nitrate of Soda is used by plants, more of the nitric acid is used than of the soda and a certain portion of the latter, is left to combine with free acids in the soil. This, like lime, neutralizes the acids and thus "sweetens" the soil for the timothy. With the assistance of the Soda set free from the Nitrate, the timothy was more than able to hold its own and thus to make what the market calls a finer, better hay; and since the market demands timothy and pays for it, the farmer who sells hay is wise if he meets the demand.

How Nitrate Neutralizes Soil Acids and Sweetens the Soil.

Financial Profit from Use of Nitrate.

How It Pays.

Frequently more plant food is paid for and put on the land than the crop can possibly use, the excess being entirely thrown away, or, at best, merely saved to benefit some subsequent crop. This was far from the case in these trials. Indeed, it was found by analysis of the hay that more potash was removed by the crops of the first two years than had been added in the muriate used, consequently the amount applied upon each plot was increased in 1901 and in 1902. The Nitrogen requirement of the crops was found to be slightly less than was supplied in 450 pounds of Nitrate and the amount was reduced to 400 pounds in 1901, and changed to 415 pounds in 1902. The Nitrate on the second plot was also reduced

Rock Before Blasting One Pound of Forty Per Cent. Dynamite.

Same Rock Shattered by the Explosion of Dynamite.

in proportion. The phosphoric acid, however, was probably in considerable excess, since liming sets free phosphoric acid already in the soil and so lessens the apparent financial profit; but not to an excessive degree.

Practical Conclusions.

From these striking results it must be evident that grass lands as well as tilled fields are greatly benefited by Nitrate, and that it would be to the advantage of most farmers to improve the fertility of their soils by growing good crops of grass, aided thereto by liberal fertilizing.

Dressing Grass Lands.

The application should be in the form of a dressing broadcasted very early in the spring in order that the first growth may find readily available material for its support and be carried through the season with no check from partial starvation.

On land which shows any tendency to sour, a ton to the acre of slaked lime should be used every five or six years. This makes the land sweet and promotes the growth of grass plants of the best kinds.

Lime should be sown upon the plowed land and harrowed into the soil. Top-dressing with lime after seeding will not answer, and, in the case of very acid soils, the omission of lime at the proper time will necessitate reseeding to secure a good stand of grass.

Grass seems to demand less phosphoric acid than was applied in the test; but it responds with increasing profit to applications of Nitrate of Soda up to 250 pounds to the acre when ample supplies of potash and phosphates are present.

No stable manure has been used upon the field under experiment for over twenty years.

Nitrate of Soda as Used in Clark's Grass Cultivation.

It may not be out of place here to mention the fact that the late Mr. Clark's success in obtaining remarkably large yields of hay for a number of years, an average of 9 tons of cured hay per acre for 11 years in succession, has been heralded throughout the United States. He attributed

his success largely to the liberal dressings of Nitrate of Soda which he invariably applied to his fields early in the spring, and which started the grass off with such a vigorous growth as to shade and crowd out all noxious weeds before they got fairly started and which resulted in a large crop of clean and high-priced hay.

It is also known that many who have tested his methods have met with failure chiefly because they neglected to

1. Without Nitrogen. 2. ⅓ Ration of Nitrogen. 3. Full Ration of Nitrogen.

All three fertilized alike with Muriate of Potash and Acid Phosphate.—R. I. Bul. 103.

How Careful Cultivation May Aid in the Profitable Use of Nitrate.

supply the young grass plants with a sufficient amount of readily available food for their use in early spring, and before the organic forms of Nitrogen, which exist in the soil only in an insoluble form and which cannot be utilized by the plants as food, are converted into soluble Nitrates by the action of bacteria in the soil. This does not occur to any great extent until the soil warms up to summer temperature when it is too late in the season to benefit the crops' early spring growth.

It is important that we always bear in mind the fact that our only source of Nitrogen in the soil for all plants is the remnants of former crops (roots, stems, dead leaves, weeds, etc.) in different stages of decomposition, and that in the early spring there is always a scarcity of Nitrogen in the soil in an available form, for the reason that the most of that which was converted into soluble

forms by the action of the soil bacteria during the warm summer months of the previous year was utilized by the plants occupying the ground at that time or has been carried down just below the reach of the roots of the young plants by the melting snow and the heavy rains of late winter and early spring, and does not come up in early spring in time to be of use.

When we consider the fact that most plants require and take up about 75 per cent. of their total Nitrate Nitrogen during the earlier stages of their growth and that Nitrogen is the element most largely entering into the building up of the life principle (or protoplasm) of all plants, it is plain that we cannot afford to jeopardize the chances of growing crops by having only an insufficient supply of immediately available Nitrogen when it is most needed.

WHAT PERCENTAGE OF WATER DOES HAY LOSE DURING STORAGE?

Result of Rhode Island Official Experiment.

Hay which had been stored during the summer was removed from the mow the following February, and found to contain 12.21 per cent. of water. A careful comparison of other moisture determinations of hay leads to the conclusion that 12.21 is a fair general average of the percentage of water in the best quality of barn-cured hay. When hay is first stored it usually contains from 20 to 28 per cent. of moisture. The loss in storage may be said to be about 12 to 16 per cent.

Growing hay for market is a subject that is receiving much attention from progressive farmers of late for several reasons, viz.:

First, growing hay for market on a portion of the farm is a partial solution of the serious labor problem; since it is much easier to get several hands during the rush of the short haying season than to get good, efficient labor for eight or more months of the year;

Second, there are usually several fields on nearly every farm in most sections, which, owing to the heavy character of the soil, or for various other reasons, are more suitable for growing hay than for growing the several crops usually grown in a regular rotation;

Third, where the method of seeding down a portion of a large farm to hay has been practiced it has frequently proven that the net profit per year from the smaller acreage devoted to grain and hoed crops, because of the more liberal fertilizing and better cultivation given them, was as great as was formerly obtained from the entire farm, leaving the value of the hay as clear gain over the old method.

The selling price per ton of good No. 1 timothy hay in the markets of America usually ranges between 10 and 20 per cent. higher than that of clover hay, the difference frequently being nearly enough to cover the cost of harvesting and marketing the crop. This, coupled with the fact that the yield per acre of timothy is about equal to that of clover, and it is much easier to cure into good marketable condition, makes it evident that timothy is the more profitable to raise for market in those States where the soil and climatic conditions are favorable.

We have been trying too often to grow timothy by seeding it with wheat or rye, and smothering it out with the grain crop the first year, and again with clover the second year, until the remaining timothy plants have become so weakened because of these unfavorable conditions and the lack of necessary plant food that they can only make a stunted growth. The result of this general method of growing hay has been an average yield for the whole country of one and one-quarter tons per acre, while, by adopting better methods, it is possible to grow three or four tons per acre and, where conditions are extremely favorable, as much as six tons of timothy per acre can often be grown in one season.

In view of the conditions here pointed out, an experiment was planned in order to determine whether on soils naturally well adapted for hay growing, but out of con-

dition, it is practicable to properly prepare the land and to maintain the meadow so as to secure profitable crops for a period of years by the use of commercial fertilizers alone.

Location of the Experiments and Condition of the Land.

The land upon which the experiments were made is located on the eastern central grazing and dairy plateau of New York, at Highlands experimental farms. Both river flatland and upland soils were used, making it possible to study both kinds of soil where climatic and seasonal conditions were the same. The character of the flatland is made up of silt, which is of considerable depth and which is still being deposited by means of overflows each spring. It was badly infested with wild sedge grass, and one portion of the meadow had not been harvested for several years. The uplands are more or less rolling, of light loam, not excessively rich in humus, and sometimes affected by droughts.

Preparation of Soil and Seeding.

Preparation for the experiments was begun in 1904; and typical areas were laid off and the land prepared in the best manner.

A method of seeding in this part of the State is to sow timothy in corn at the last cultivation, usually the latter part of July. The corn is planted as early as possible, and just before the last cultivation 20 quarts of timothy seed are used per acre.

In this experiment the flatland crop of wild sedge grass was cut early in June, the field plowed, and was then frequently cultivated until about the first of September, when it was carefully seeded at the rate of 20 quarts of timothy per acre.

Two methods of seeding were practiced on the upland; in one case the pasture was plowed early, seeded to oats, and as soon as the crop was harvested, the stubble was plowed, then frequently cultivated, and seeded with 20 quarts of timothy per acre about the 15th of September.

In the other case, the pasture land was plowed in June, rolled down and thoroughly and frequently cultivated and similarly seeded about the 24th of September. The latter method, however, did not kill the native grass, and is not recommended.

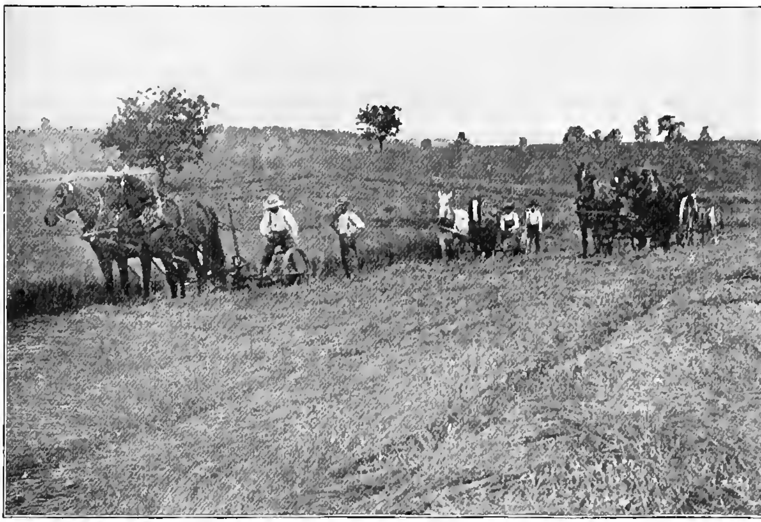
Crop of Grass Grown by the Use of Nitrate of Soda.

Fertilizers Used.

Since one object of this experiment was to determine whether profitable cropping could be continued for more than one season, the land was not only thoroughly prepared, but amply supplied with phosphoric acid, potash and lime, in order that there might be no deficiency in the quantity of mineral constituents required for the crop. On the highest and most gravelly portion of the upland, stable manure was applied to supply humus and increase the absorptive power of the soil, and on all the land one ton of lime was applied per acre before plowing.

After plowing and rolling and before harrowing, there was applied to each acre 600 pounds acid phosphate, 200 pounds sulphate of potash, and, in addition to this, the lowland received an application of 740 pounds of basic slag phosphate, and the upland 540 pounds. The Nitrogen was all in the form of Nitrate, and was applied broadcast in the spring.

The following table shows the kinds and amounts of fertilizers that were applied for the crops of 1905 and 1906:



The Tedders follow the Mowing Machines for rapid curing of heavy crops of hay.

Kind and Quantity of Fertilizers Used Per Acre.

	Upland		Lowland	
	1905, Pounds	1906, Pounds	1905, Pounds	1906, Pounds
Lime	2,000	....	2,000	....
Wood Ashes	....	520	....	520
Acid Phosphate	600	578	600	578
Basic Slag	540	....	740	....
Sulphate of Potash	200	....	200	....
Nitrate of Soda	200	168	200	112

The mineral fertilizers for the crop of 1905 were applied in the fall of 1904, those for the crop of 1906 were

applied during the summer of 1905. The Nitrate of Soda was all applied broadcast in the spring, and was evenly distributed as soon as the grass had nicely started. The quantities of Nitrate applied were not as large as is sometimes recommended, but were sufficient to provide for a large yield.

The effect of the thorough preparation of soil was noticeable at once in the good stand of plants secured, and in the vigorous growth and good top made in the fall. The plants wintered well, and after the Nitrate application had been made the grass on these plots grew luxuriantly, and made a large yield of hay.

The main point was to determine whether it was a paying proposition, and the following tables show the yield and value of crops, as well as the profits derived when mineral fertilizers only are used, and also when Nitrate of Soda is used in addition.

Yield of Crops in 1905.

	Upland		Lowland	
	Without Nitrate	With 200 lbs. Nitrate per acre	Without Nitrate	With 200 lbs. Nitrate per acre
Yield per acre....	3,180 lbs.	8,340 lbs.	6,985 lbs.	8,712 lbs.
Increase from Nitrate	5,160 lbs.	162%	1,727 lbs.	24.7%

These results are strikingly significant, showing in the first place the difference in adaptability of the two soils for hay growing. The upland was deficient in humus, and being dry and gravelly, was unable to provide Nitrogen in any quantity although an abundance of minerals was present. The lowland, on the other hand, containing a large proportion, was capable of furnishing the Nitrogen needed for a relatively large crop, or more than double that on the upland. This is a very clear illustration of the importance of the use of Nitrogen with minerals, if full crops are to be produced. The application of Nitrate of Soda on the upland proved much more efficient than on the lowland, not only in supplying Nitrogen in immediately available forms, but in energizing the plants to obtain more from the soil,

showing a gain in yield of 162 per cent., while on the lowland the gain was but 24.7 per cent.; the soil itself being able in the latter case to supply a larger proportion of the Nitrogen required to produce a crop as large as the climatic and seasonal conditions would permit. The following table shows the financial results of the two experiments from two standpoints: (1) Whether it is profitable to grow hay under the conditions, as outlined here; and (2) whether the use of Nitrate will pay.

1905. *Cost of Crops.*

	Yield, pounds	Preparation and seeding and cost of mineral fertilizers	Nitrate of soda	Application of Nitrate	Harvesting	Total	Gross value of crop	Net profit on crop	Gain from Nitrate
UPLAND:									
With Nitrate	8340	$5 19	$5 20	$0 30	$8 34	$19 03	$50 24	$31 21	$20 50
Without Nitrate	3180	5 19	......	......	3 18	8 37	19 08	10 71	......
LOWLAND:									
With Nitrate	8712	5 42	5 20	0 30	8 71	19 63	52 27	32 64	3 14
Without Nitrate	6985	5 42	......	......	6 99	12 41	41 91	29 50	......

The first point of importance shown by this detailed statement is that notwithstanding the expense involved, there is a profit in hay growing; that it pays to expend money for the good preparation of soil, for good seed and for fertilizers — in fact, if the entire cost had been charged to the first crop, there would have been a profit of $5.23 per acre where Nitrate was used on the upland. Second, that it pays to use Nitrate; and third, that the kind of soil to which Nitrate is applied measures in a marked degree the profit to be derived from its application. On the upland, the crop without Nitrate was worth but $19.08 per acre, while the application of 200 pounds of Nitrate caused the value to increase to $50.24 — a gain of $31.16 per acre. Deducting the cost of the nitrate and extra cost of harvesting, we have a net increase in value of $20.50 per acre, or for each dollar invested a net return of nearly $4.

On the lowland, the crop without Nitrate was worth $41.91 per acre, and, with Nitrate, $52.27, a gain of $10.36, which is reduced to $3.14 when the cost of Nitrate and harvesting is deducted, still a good profit on the investment, though clearly indicating that Nitrogen was not the limiting factor in crop production as was the case on the upland. In making the tables, the actual cost of labor, seed and fertilizers was used. The value of the hay was estimated at $12 per ton, and based on weights at time of harvesting. The shrinkage of hay will range from 15 to 25 per cent.; assuming the shrinkage to be as unusually high as 25 per cent., the value per ton would have to increase to $16 to balance, which is lower than prevailing prices have been since that year for No. 1 timothy.

Crops of 1906.

The experiment was continued in 1906, on the same areas. In order to insure a constant and abundant supply, mineral fertilizers were again added in the form of wood ashes and acid phosphate, and in the amounts shown in the table, namely, 520 pounds of wood ashes and 578 pounds of acid phosphate per acre on both the fields.

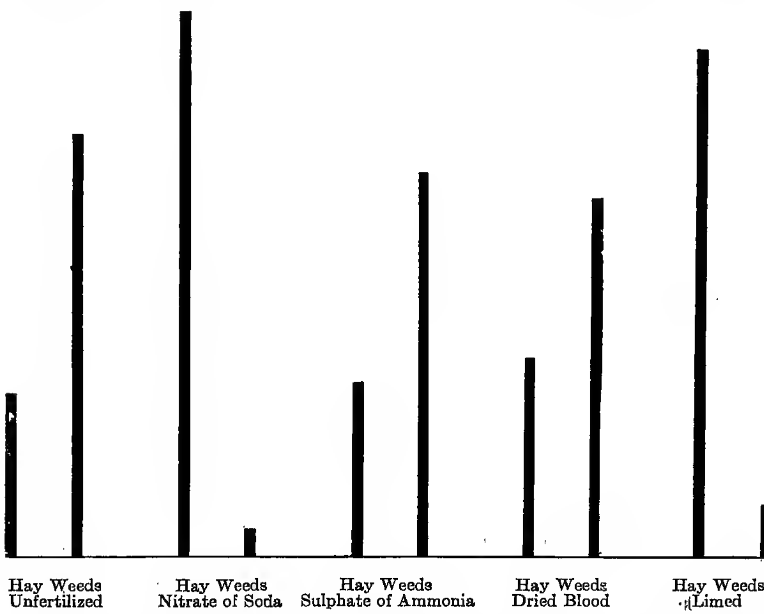
The applications of Nitrate were, however, reduced from 200 to 168 pounds on the upland; and to 112 pounds on the lowland per acre. These fertilizers were all evenly distributed in the spring of 1906. The effect of the Nitrate was again immediately noticeable in increasing the vigor of the plants. The yields were as follows:

Yield of Crops in 1906.

	UPLAND		LOWLAND	
	Without Nitrate	With 168 lbs. Nitrate per acre	Without Nitrate	With 112 lbs. Nitrate per acre
Yield per acre....	3,200 lbs.	6,240 lbs.	5,920 lbs.	8,080 lbs.
Increase from Nitrate	3,040 lbs.	95.0%	2,160 lbs.	36.4%

These results confirm those for 1905 on the whole, though there are points of difference which may be rea-

sonably charged to season and to the effect of the growth of the first crop. On the upland, which was poor in humus and Nitrogen, the yield of the plot without Nitrate differs but little from that of 1905, while on the lowland, the soil rich in humus, the yield without Nitrate is much lower than in 1905. On the upland the Nitrogen at the disposal of the plant did not exist in easily changeable forms, and hence was not largely exhausted under the energy of the extra mineral food. The lowland, on the



other hand, doubtless contained considerable Nitrogen in easily changeable forms, which under the influence of the available phosphoric acid and lime was made effective on the grass, and resulted in a comparatively large yield, leaving the soil much poorer in Nitrogen for the next crop.

It would appear from this reasoning, that the need for applied Nitrogen, while greater for the upland in 1905 than in 1906, is not so striking as in the lowland. This

assumption is borne out by the facts; the gain on the upland in 1906 is 3,040 pounds, or 95 per cent., as against a gain of 5,160 pounds, or 162 per cent. in 1905; while the gain on the lowland is 36.4 per cent. in 1906, as against 24.7 per cent. in 1905. The lower percentage increase in yield from Nitrate on the upland being due in part, at least, to the fact that the Nitrate used in 1905 energized the plants to acquire more from soil sources than was possible with the use of minerals only, and in part to the lower quantity applied in 1906, 168 pounds instead of 200 pounds.

On the lowland the greater percentage increase this year, due to Nitrate, is for the same reason that it was greater in 1905 on the upland than in 1906. This is a clear demonstration again of the influence of character of soil as a determining factor. Instead of reducing the amount of Nitrate used in 1906, it should have been increased, especially on the upland. The value of crop and profits are also influenced by the smaller amounts of Nitrate applied, as shown in the comparative profits in the tabulated statement.

1906. *Cost of Crops.*

	Yield, pounds	Preparation and seeding	Mineral fertilizers and Nitrate	Application of fertilizer	Harvesting	Total	Gross value of crop	Net profit on crop	Gain from Nitrate
UPLAND:									
With Nitrate............	6240	$5 19	$12 60	$0 90	$6 24	$24 93	$37 44	$12 51	$10 20
Without Nitrate.........	3200	5 19	7 90	60	3 20	16 89	19 20	2 31	......
LOWLAND:									
With Nitrate............	8080	5 42	11 04	90	8 08	25 44	48 48	23 04	7 36
Without Nitrate.........	5920	5 42	7 90	60	5 92	19 84	35 52	15 68	......

In making up this table, the actual cost of labor and fertilizers is recorded, while the value of dry hay was estimated to be $12 per ton when stored, as in 1905.

As a whole, the results confirm those of 1905 in showing a profit in all cases, ranging from $2.31 per acre.

without Nitrate, on the upland, to $23.04 with Nitrate, on the lowland. It is to be expected from the preceding discussion that the relative profits from the use of Nitrate on the two areas is changed, the net profit of $20.50 on the upland being reduced to $10.20, and that of $3.14 on the lowland being increased to $7.36 per acre. These net results, secured under what would be regarded as expensive methods, are certainly satisfactory from a financial standpoint, and indicate that on lands requiring expensive treatment hay growing may be made profitable and warrant the following general suggestions as to the growing of profitable crops:

The essential conditions necessary for obtaining maximum crops of timothy are, first, a clean, thick stand of healthy timothy plants; second, an abundance of available plant food is needed by the plants to make a normal growth.

It must not be overlooked that available plant food at the right time implies that there shall be sufficient moisture present in the soil to carry the plant food into the roots of the plants in a soluble form; and just in proportion as we fail to have a sufficient supply of moisture present when needed, we render our supply of plant food unavailable as far as plant growth is concerned. Thus, it is well known that very frequently the limiting factor in the growth of plants is a lack of sufficient moisture in the soil at a critical time rather than a deficiency of actual plant food in the soil.

For this reason it is best to select those portions of a farm for growing timothy, in which the soil is rather heavy and retentive of moisture. When there is a supply of stable manure available for use in hay growing, it should, whenever possible, be plowed under or otherwise worked into the soil before seeding, and not be used as a top-dressing on meadows already seeded, for the reason that the chief value of stable manure is that it adds large quantities of humus-making material to our soils, and *the soils need their humus in them and not on them.*

For similar reasons stable manure should be applied to those soils most deficient in humus and not to the muck lands and those that are naturally moist.

Preparing Land.

The river-bottom lands, because of their silt formation and the added fertility which they receive in their annual overflow, together with their abundant supply of moisture during the entire season, are able to produce the largest crops of timothy, at the lowest cost per ton, but these soils are usually very foul with quack, sedges and wild grasses, which must be largely eradicated, in order to get a stand of clean timothy.

Where there are stumps or rocks that would interfere with the operations of haying machinery, it is advisable to remove them wherever possible, and it was found that the judicious use of dynamite effected a great saving in the time and expense of this operation.

After plowing, the land should be rolled and then thoroughly worked every week or ten days up to seeding time. The field should be worked in small lands, going around each land, and always lapping the harrow one-half, so that the surface may be kept level.

If there are any deep holes in the field, resulting from the removal of boulders or other cause, they should be filled in at the time of the first harrowing, and if there are any surface ditches they should be made shallow with gradually sloping sides, wherever possible, so that the entire surface of the field can be gone over with a mowing machine in any direction when the hay crop is to be harvested.

The difference in the expense of preparing a field right, or only partially so, is slight, when considering possible breakage of machinery when harvesting the crops of several years, figured on the basis of low cost per ton of product, and this factor is of double importance in the preparation of land on which it is possible to harvest two crops each season.

Liming.

It is known that timothy cannot thrive and yield maximum crops in a sour soil, while red-top seems to delight in such soil, and one of the surest indications that a soil is sour is when we find the timothy meadow run out after two or three years and the ground occupied by red-top. The presence of sorrel, five-finger mosses, daisies and mulleins are also indications of a sour soil, and timothy cannot be made to do its best on those soils until they are made sweet. The quickest and most practical way to accomplish this is by the liberal application of lime in some form. This may be applied in the form of stone lime, either ground or unground, or air-slaked; or in connection with potash in wood ashes. The amount of lime to apply should be generally about one-half ton per acre.

If we use lime in the form of ashes or ground stone lime, it can be drilled into the soil at the right depth with a fertilizer drill, but if we use air-slaked lime or lump lime and slake it in the field, it should be spread either before plowing or immediately after the first harrowing and before the ground is rolled, so that the bulk of the lime will get down into the soil at the right depth.

Mineral Fertilizers.

This question of the correct application of the mineral elements of plant food is of great importance, and has not received the consideration it deserves — especially is this so in regard to fertilizing meadows or grass lands, which usually remain seeded down for several years, and there is no time after the seed is sown that the phosphoric acid and potash can be gotten down into the soil where they belong, which place is from three to six inches under the surface. When phosphoric acid or potash are used as a top-dressing for meadows, it is known that they become fixed largely in the surface and consequently tend to attract the feeding roots of the plants to the surface

of the soil, where they are least able to withstand the effects of drought, which is so often such a serious factor.

The amount of phosphoric acid and potash to be used depends upon the soil entirely, and can only be approximated, but the fact that they both become fixed in the soil so that there is practically no danger of loss from one season to another, allows us to be more liberal than we otherwise would, and since the best time to apply it is before the seed is sown, we should be liberal in regard to the quantity used for obvious reasons.

For good, medium clay land of average fertility, there should be drilled into the soil broadcast, at least 400 pounds per acre of 14 per cent. acid phosphate and 100 pounds per acre of sulphate of potash or its equivalent. If the soil is poor, sandy or gravelly or is a peaty or muck soil, which are known to be usually deficient in these elements, the quantity of each should be doubled. Remember when it comes to fertilizing our crops, the question we should ask ourselves is not "how much will it cost me to furnish my crop with the food that it needs?" but "how much will it cost me *not* to do so?"

Acid phosphate appears to be the safest and the best form in which to apply phosphoric acid to soils for hay growing generally.

Potash salts. High-grade sulphate of potash is one of the most satisfactory of the commercial potash salts and its use does not tend to deplete the soil of its lime as does the use of muriate of potash. The phosphoric acid and potash should be applied to the soil broadcast to the depth of at least three inches from one to two weeks before sowing the seed. Hardwood ashes are excellent when not adulterated, as a source of potash and lime.

Seeding.

Twenty quarts per acre of the best recleaned timothy seed obtainable is the right quantity to sow per acre, and this should be sown between August 15th and September 15th, the time that timothy naturally reseeds itself.

It can best be sown with a wheelbarrow, broadcast grass seeder, sowing ten quarts each way of the field for most even distribution, after which the seed should be dragged into the soil about one inch deep, by going over the field once or twice with a slant-tooth drag or a weeder with sufficient weight attached to obtain the desired result.

Finish the operation by going over the field with a roller, to roll down the loose stones on the surface and to compact the surface soil, thus bringing the moisture to the surface so that the seed will all germinate at once and come up evenly over the entire field.

Nitrate Application.

So far we have insured a good, clean, thick stand of healthy timothy plants, and we have supplied them liberally with the mineral plant foods that are liable to be deficient in the soil, but we have made no provision for the plants having an abundant supply of available Nitrogen the next spring when they are making their most rapid growth, and their need is greatest. At that time there is always a scant supply of soluble Nitrogen in the surface soil, owing to the fact that when the excess moisture settles down into the lower levels of the soil it carries Nitrogen in solution with it, and the stores of humus Nitrogen are not rendered soluble, except in very slight amounts, until the soil warms up to a degree of temperature wherein the soil bacteria again become active and convert organic and other forms of Nitrogen into Nitrates.

To overcome this natural deficiency of soluble Nitrogen at a critical time in the growth of the timothy plants, we must supply it in an available form, and this can best be done by applying broadcast about 100 to 200 pounds of Nitrate of Soda per acre as a top-dressing as soon as growth starts in the spring.

Cornell University Experiment Station Bulletin, No. 247, p. 203, puts it thus:

"Having water-soluble Nitrogen on tap at the right hour and the right place is *one* of the factors that enable the Cornell Station to grow

three and one-half tons of timothy hay on Dunkirk clay loam, when without this artificial help only about one and one-half tons could be raised."

Report of Experiments.

Season of 1906.

Highland Experimental Farms, New York.

The average yields per acre of field-cured hay on the uplands were as follows:

No Nitrate — 3,200 pounds per acre.

168 lbs. Nitrate — 6,240 pounds per acre.

The average yields per acre of field-cured hay on the lowlands were as follows:

No Nitrate — 5,920 pounds per acre.

112 lbs. of Nitrate — 8,080 pounds per acre.

Comparative Summary of Timothy Hay Yields, 1905 *and* 1906.

Uplands.

1905. No Nitrate — 3,180 lbs. 300 lbs. Nitrate — 8,340 lbs.
1906. No Nitrate — 3,200 lbs. 168 lbs. Nitrate — 6,240 lbs.

Lowlands.

1905. No Nitrate — 6,985 lbs. 200 lbs. Nitrate — 8,712 lbs.
1906. No Nitrates — 5.920 lbs. 112 lbs. Nitrate — 8,080 lbs.

Yield of original " No Nitrate " hollow square plot in field of timothy and red top:

Season of 1905 — 3,180 lbs.
Season of 1906 — 1,760 lbs.

The yields are lower for 1906 than for 1905 owing to smaller applications of Nitrate and probably also to the fact that there was much less rainfall during the growing season.

Distribution of Nitrogen in the Grain and Straw of the Principal Cereals.

NITROGEN PER TWO AND ONE-HALF ACRES.

Grain.

Oats,	Barley,	Wheat,	Rye,
82.42 lbs.	86.61 lbs.	81.10 lbs.	67.44 lbs.
Rape Seed	Peas,	Vetches,	Broad Beans,
176.32 lbs.	117.03 lbs.	143.92 lbs.	181.16 lbs.

Straw.

Oats,	Barley,	Wheat,	Rye,
26.4 lbs.	26.4 lbs.	33.06 lbs.	29.31 lbs.
Rape Seed,	Peas,	Vetches,	Broad Beans,
29.75 lbs	118.35 lbs.	112.40 lbs.	79.34 lbs.

Distribution of Nitrogen in the Principal Root Crops.

NITROGEN PER TWO AND ONE-HALF ACRES.

	Sugarbeet,	Beetroot,	Swedes,	Carrots,	Potatoes,
Roots.	105.79 lbs	138.85 lbs.	165.30 lbs.	145.46 lbs.	112.40 lbs. TUBERS.
Leaf.	52.89 lbs.	80.66 lbs.	55.1 lbs.	168.60 lbs.	15.11 lbs. SHAWS.

GRADES OF HAY AND STRAW.

Adopted by the National Hay Association.

Hay.

No. 1 Timothy Hay: Shall be timothy with not more than one-eighth (1/8) mixed with clover or other tame grasses properly cured, good color, sound and well baled.

Standard Timothy: Shall be timothy with not more than one-eighth (1/8) mixed with clover or other tame grasses, fair color, containing brown blades, and brown heads, sound and well baled.

No. 2 Timothy Hay: Shall be timothy not good enough for No. 1 not over one-fourth (1/4) mixed with clover or other tame grasses, fair color, sound and well baled.

No. 3 Timothy Hay: Shall include all hay not good enough for other grades, sound and well baled.

Light Clover Mixed Hay: Shall be timothy mixed with clover. The clover mixture not over one-third (1/3) properly cured, sound, good color and well baled.

No. 1 Clover Mixed Hay: Shall be timothy and clover mixed, with at least one-half (1/2) timothy, good color, sound and well baled.

Heavy Clover Mixed Hay: Shall be timothy and clover mixed with at least one-fourth (1/4) timothy sound and well baled.

No. 2 Clover Mixed Hay: Shall be timothy and clover mixed with at least one-third (1/3) timothy. Reasonably sound and well baled.

No. 1 Clover Hay: Shall be medium clover not over one-twentieth (1/20) other grasses, properly cured, sound and well baled.

No. 2 Clover Hay: Shall be clover sound, well baled, not good enough for No. 1.

Sample Hay: Shall include all hay badly cured, stained, threshed or in any way unsound.

Choice Prairie Hay: Shall be upland hay of bright, natural color, well cured, sweet, sound, and may contain 3 per cent. weeds.

No. 1 Prairie Hay: Shall be upland and may contain one-quarter (¼) midland, both of good color, well cured, sweet, sound, and may contain 8 per cent. weeds.

No. 2 Prairie Hay: Shall be upland, of fair color and may contain one-half midland, both of good color, well cured, sweet, sound, and may contain 12½ per cent. weeds.

No. 3 Prairie Hay: Shall include hay not good enough for other grades and not caked.

No. 1 Midland Hay: Shall be midland hay of good color, well cured, sweet, sound, and may contain 3 per cent. weeds.

No. 2 Midland Hay: Shall be fair color or slough hay of good color, and may contain 12½ per cent. weeds.

Packing Hay: Shall include all wild hay not good enough for other grades and not caked.

Sample Prairie Hay: Shall include all hay not good enough for other grades.

Straw.

No. 1 Straight Rye Straw: Shall be in large bales, clean, bright, long rye straw, pressed in bundles, sound and well baled.

No. 2 Straight Rye Straw: Shall be in large bales, long rye straw pressed in bundles, sound and well baled, not good enough for No. 1.

No. 1 Tangled Rye Straw: Shall be reasonably clean rye straw, good color, sound and well baled.

No. 2 Tangled Rye Straw: Shall be reasonably clean, may be some stained, but not good enough for No. 1.

No. 1 Wheat Straw: Shall be reasonably clean wheat straw, sound and well baled.

No. 2 Wheat Straw: Shall be reasonably clean; may be some stained, but not good enough for No. 1.

No. 1 Oat Straw: Shall be reasonably clean oat straw, sound and well baled.

No. 2 Oat Straw: Shall be reasonably clean; may be some stained, but not good enough for No. 1.

Alfalfa.

Choice Alfalfa: Shall be reasonably fine leafy alfalfa of bright green color, properly cured, sound, sweet, and well baled.

No. 1 Alfalfa: Shall be reasonably coarse alfalfa of a bright green color, or reasonably fine leafy alfalfa of a good color and may contain 2 per cent. of foreign grasses, 5 per cent. of air bleached hay on outside of bale allowed, but must be sound and well baled.

Standard Alfalfa: May be of green color, of coarse or medium texture, and may contain 5 per cent. foreign matter; or it may be of green color, of coarse or medium texture, 20 per cent. bleached and 2 per cent. foreign matter; or it may be of a greenish cast of fine stem and clinging foliage, and may contain 5 per cent. foreign matter, all to be sound, sweet, and well baled.

No. 2 Alfalfa: Shall be of any sound, sweet and well baled alfalfa, not good enough for standard, and may contain 10 per cent. foreign matter.

No. 3 Alfalfa: May contain 35 per cent. stack-spotted hay, but must be dry and not to contain more than 8 per cent. of foreign matter; or it may be of a green color and may contain 50 per cent. foreign matter; or it may be set alfalfa and may contain 5 per cent. foreign matter, all to be reasonably well baled.

No grade Alfalfa: Shall include all alfalfa not good enough for No. 3.

The Alfalfa, Cow Pea and Clover Question.

Use of Legumes.

This class of plants has the property of taking inert Nitrogen from the air and transforming it into combinations more or less useful as plant food. This

feature is of great value to agriculture, but not so much from the plant food point of view as from the fact that these plants are rich in that kind of food substance commonly called "flesh formers." Liberally fertilized, and not omitting Nitrate in the fertilizer, we have a crop containing more nitrogenous food (protein or flesh formers) than the Nitrogen actually given as fertilizer could have made by itself. The most common plants of this class are: Alfalfa, alsike clover, crimson clover, red clover, Japan clover, cow peas, lupines, Canadian field peas, the vetches, etc. All these forage crops should be sown after clean culture crops. The best method of fertilizing is to apply from 300 to 500 pounds of fertilizer early every autumn; in the spring broadcast 200 pounds of Nitrate of Soda, and repeat with about 100 pounds after each cutting. It is true that clovers *may* supply their own nitrogenous plant food, but this is an experiment experienced farmers do not often repeat. A fair green crop of clover, for example, removes from the soil some 160 pounds of Nitrogen, while in 500 pounds of Nitrate of Soda there are less than 100 pounds. Undoubtedly, the Nitrogen taken from the air is a great aid, but we should not expect too much of it. The method of seeding clovers depends much upon locality and soil needs with reference to previous crops. Crimson clover and Canadian field peas are usually sown in August, after earlier crops have been removed, or even in corn fields. Red clover is commonly sown in the spring on wheat or with oats.

Wheat.

The soil for this grain, fall planting, ranges from a clay loam to a moderate sandy loam. For spring wheat, moist peaty soils are used. Wheat is usually grown in rotation, in which case it nearly always follows corn, or a clean culture crop. The nature of cultivation is too well known to require mention here. Both spring and winter wheat are commonly fertilized crops, particularly

the latter. The average fertilizer for wheat should contain Nitrogen, phosphoric acid and potash. This fertilizer is applied with the seed, and at the rate of 500 pounds to the acre. Nitrate of Soda is also applied broadcast as a dressing, soon after the crop shows growth in the spring, at the rate of 100 pounds per acre. Like all grains, wheat should have its Nitrate plant food early, and in the highly available, easily digested nitrated form, such as is only to be found commercially as Nitrate of Soda.

Wheat.

Wheat — 14 Bushels.
Average product per acre for the U. S. of wheat with average farm fertilization.

Wheat — 37 Bushels.
The product of an acre of wheat fertilized with Nitrate of Soda, phosphates and potash.

The plant food needs of a crop of 30 bushels of wheat per acre amounts to about 70 pounds of Nitrogen, 24 pounds of phosphoric acid, and 30 pounds of potash; this includes the straw, chaff and stubble. One hundred pounds of Nitrate of Soda supplies about 16 pounds of Nitrogen, so that the quantity mentioned for application is a minimum quantity. Much has been said of legume

Nitrogen for wheat, the crop being generally grown in rotation. Whatever Nitrogen the clover may have gathered, a crop of timothy and a crop of corn must be supplied before the wheat rotation is reached. In all cases where the acre yields have fallen off, a broadcast dressing of Nitrate of Soda should be given.

How to Apply Nitrate of Soda to Wheat.

Drill in with the wheat in the fall a mixture of 150 pounds of acid phosphate and 50 pounds Nitrate of Soda per acre. If your land is sandy, add 50 pounds of sulphate of potash to the above. Early in the spring, sow broadcast 50 more pounds Nitrate of Soda per acre.

Land sown to wheat in the fall and seeded down with timothy and clover giving a heavy crop, followed by a heavy hay crop the following year, proved the beneficial after-effect of the Nitrate and that the Nitrate had not leached away as so many critics claim, and further that the soil had not been exhausted.

Professor Massey writes in regard to the effect of Nitrate of Soda on Wheat, as follows:

"I have made several experiments with Nitrate of Soda. The first was on wheat in Albemarle County, Virginia. I used 200 pounds per acre on part of the field which had been fertilized with 400 pounds acid phosphate in the fall. The result was 9 bushels per acre more than on the rest of the field, and a stand of clover, while none of any account stood on the rest of the field."

Instructions for using Nitrate of Soda on Wheat.

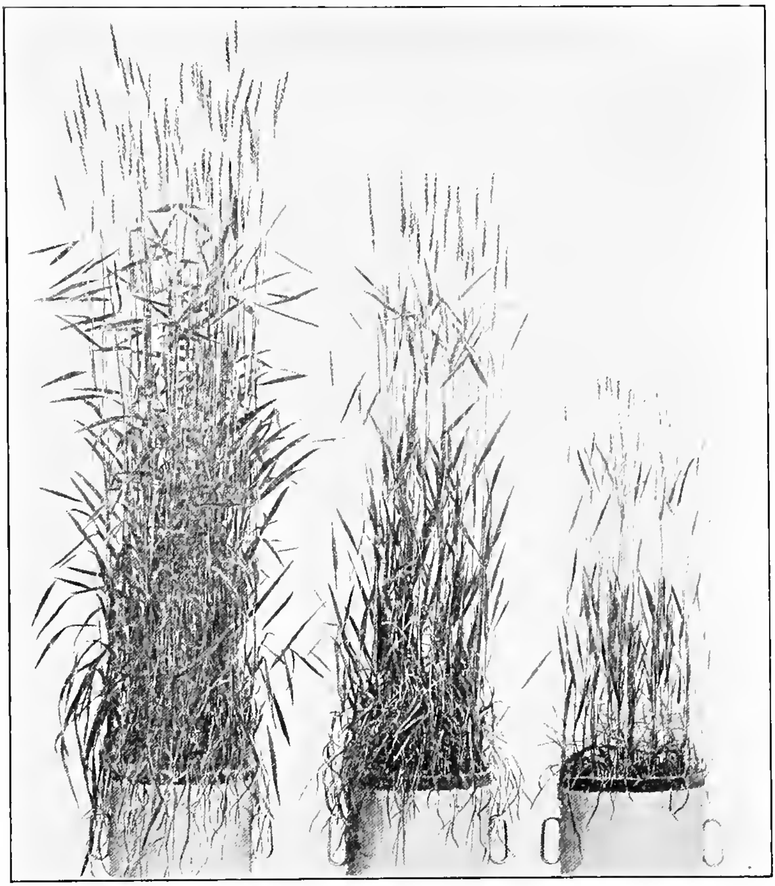
As soon as frost leaves the ground in the spring, apply the Nitrate of Soda by broadcasting it evenly, by hand or by machine, over the entire surface of the wheat field you are fertilizing, at the rate of 100 pounds per acre, which is equal in bulk to one bushel.

Formula for Wheat.

Nitrate alone	100 lbs. per acre
or preferably	
Nitrate	150 " " "
Acid Phosphate	150 " " "

When potash salts can be conveniently obtained we advise the use of fifty pounds of sulphate of potash to the acre every other year.

Fertilizer Experiment with Wheat.



Phosphoric Acid and Potash with 1 oz. Nitrate of Soda. Yield: 3⅕ oz. Grain.

Phosphoric Acid and Potash with ¼ oz. Nitrate of Soda. Yield: 1½ oz. Grain.

Phosphoric Acid and Potash without Nitrate of Soda. Yield: ½ oz. Grain.

Oats.

This grain does well on nearly all types of soil, but responds freely to good treatment. There is a vast difference in the quality of oats when grown on poor or rich soils. Perhaps no other crop so effectually conceals impoverishment; at the same time the feeding value of oats grown on poor soil is very low. In the North oats

Oats.

30 Bushels. Average product per acre, for the U. S. of oats, with average farm fertilization.

65 Bushels. The product of an acre of oats fertilized with Nitrate of Soda.

are sown in the spring, and usually after corn or a turned down clover sod. In such cases the crop is rarely ever given fertilizer, but shows an excellent return for a broadcast dressing of 100 pounds of Nitrate of Soda per acre. The crop has strong foraging powers, and will find available mineral plant food where a wheat crop would utterly fail. On soils pretty badly exhausted, an application of 400 pounds of fertilizer will yield a profitable return, provided the dressing of Nitrate is not omitted. Under any condition of soil or fertilizing, a sickly green color of the young crop shows need of Nitrate of Soda plant food, and the remedy is a dressing of Nitrate. In seeding, use two or three bushels to the acre.

In many places in Europe the cereals, like oats and wheat, are planted or sown in rows and cultivated as we cultivate Indian corn. It is claimed that this increases yield materially, and is of great aid in helping to avoid lodging. It requires less seed per acre and increases the yield.

Another method in vogue is to sow less seed per acre broadcast and use more fertilizer, so that the individual stalks are stronger and bigger.

Autumn dressings of Nitrate are used frequently in Europe, and in connection with minerals a dressing of as much as three hundred (300) pounds of Nitrate per acre is used annually.

Instructions for Using Nitrate of Soda on Oats.

As soon as you sow the oats in the spring, apply the Nitrate of Soda by broadcasting it evenly, by hand or machine, over the entire surface of the oat field at the rate of 100 pounds per acre. In bulk this is equal to about one bushel.

Formula for Oats.

Nitrate alone	100 lbs. per acre
or preferably	
Nitrate	150 " " "
Acid Phosphate	150 " " "

When potash salts can be conveniently obtained we advise the use of fifty pounds of sulphate of potash to the acre every other year.

Rye.

This is another illustration of the necessity of care in the use of fertilizer Nitrogen. Rye does best on light soils so long as they are not too sandy, but if the soil is rich in vegetable matter, or if a fertilizer is used containing much organic ammoniate, the grain yield will be disappointing; the crop fails to mature in season because the nitration of organic Nitrogen or humus is greatest

during the warm days of mid-summer, and a constant supply of available Nitrate is being furnished at a time when the crop should commence to mature. The crop needs Nitrate, but it should have been supplied during the earlier stages of growth. Use at first a general fertilizer, 500 pounds per acre. As soon as the crop shows growth, in the spring apply 100 pounds of Nitrate of Soda to the acre, broadcast.

Rye.

Rye — 18 Bushels.
Average product per acre for the U. S. of rye with average farm fertilization.

Rye — 36 Bushels.
The product of an acre of rye fertilized with Nitrate of Soda, phosphates and potash.

Instructions for Using Nitrate of Soda on Rye.

Just as soon as growth starts in the spring, or a little earlier if possible, apply the Nitrate of Soda by broadcasting it evenly, by hand or by machine, over the entire surface of the rye field you are fertilizing, at the rate of 100 pounds per acre, which is equal in bulk to one bushel.

Formula for Rye.

Nitrate alone	100 lbs. per acre
or preferably	
Nitrate	150 " " "
Acid Phosphate	150 " " "

When potash salts can be conveniently obtained we advise the use of fifty pounds of sulphate of potash to the acre every other year.

Buckwheat.

This crop does well on almost all kinds of soil, but should follow a grain or hoed crop — that is, a clean cultivation crop. On thin soils use about 400 pounds of

Buckwheat.

No Nitrate.
Yield, 19 bushels per acre.

Fertilized with 125 lbs. Nitrate of Soda per acre.
Yield, 38 bushels per acre.

general fertilizer to the acre, applied just before seeding, or even with the seed. Heavy soils do not require fertilizing for this crop, as it has exceptional foraging powers, and will find nourishment where many grain crops would starve. As soon as the plants are well above ground, broadcast 100 pounds of Nitrate of Soda per

acre, both on strong and light soils. Use one bushel of seed per acre on thin soils, but a heavier application on richer soils.

In many places in Europe the cereals, like oats and wheat, are planted or sown in rows and cultivated as we cultivate Indian corn. It is claimed that this increases yield materially, and helps to avoid lodging. It requires less seed per acre and increases the yield.

Another method in vogue is to sow less seed per acre broadcast and use more fertilizer, so that the individual stalks are stronger and bigger.

ORANGE GROVES IN FLORIDA.

An orange that weighs a pound would sell in New York for a dime. When it takes as many as six to weigh a pound they are almost worthless.

Satisfactory results have been obtained in Florida by fertilizing during the cold season. About two months before the period of growth begins, apply to each full-grown tree a mixture of 7 pounds of 14 per cent. acid or superphosphate and 4 pounds of sulphate of potash, by working them into the soil; after which 4 pounds of Nitrate of Soda may be likewise applied. The working of the soil must not be so deep or thorough as to start the growth of the tree. An excess of Nitrate is to be avoided, but the amount mentioned is not too much. All other ammoniates on the market must be converted into Nitrate by weathering and the action of the soil bacteria before they can possibly be available for plant food. Nitrate of Soda is a predigested Nitrogen. There is a danger of loss of Nitrogen in all other forms as they must be converted into Nitrate before becoming available as food, and during this comparatively long process much of it may be lost by rains and leaching, since they suffer in fact from many days of long exposure to the adverse condition.

In the case of your particular soil, it may well be that it is sufficiently rich in potash, and therefore, may not

require a large application of it. In any event, the grower must be governed by the condition of his grove and the general character of soil and climate in his particular locality.

The early decay of orchards as well as failure to set fruit buds, is largely a matter of lack of plant food. Orchards should have Nitrate, applied early in the season, as late supplies of Nitrogen are liable to cause a heavy setting of leaf buds at the expense of next year's fruit. The ordinary ammoniates are not satisfactory for orchard work, as they continue to supply available ammonia all through the season; not enough in the early part of the year to properly set the fruit, hence severe dropping; too much late in the year when none is needed and which causes the formation of leaf rather than fruit buds. The soil between the trees should be regularly tilled, much as in corn growing. That it is not generally done is no argument against the value of such cultivation methods.

Instructions for Using Nitrate on the Citrus in California.

Under ordinary conditions in California — for full-grown orange trees — we advise applying Nitrate early in March or even the middle of February, and follow the application immediately after by disking or harrowing in the material to the depth of five or six inches.

When it is used alone, Nitrate may be used at the rate of two hundred (200) pounds to the acre.

It can be used more profitably at the rate of four hundred (400) pounds to the acre if four hundred (400) pounds of dry acid or superphosphate be used with it. Both materials should be dry.

Four hundred pounds of Nitrate is equal in bulk to about four bushels.

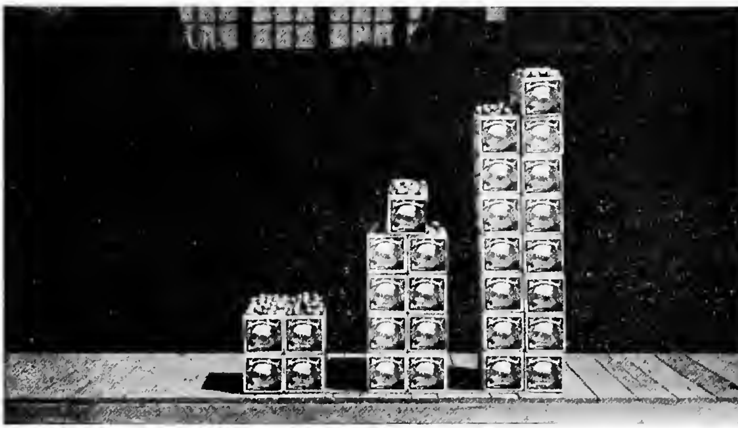
We believe the second procedure is the more profitable as a rule, and we have no hesitation in recommending it

in preference to the use of Nitrate alone. The earlier the application, the better the results.

After plowing in the material in February, the orchard should be cultivated every thirty (30) days until August, preferably in the forepart of each month. The last cultivation is done best by a disk harrow.

Results at Highgrove.

Yields of 3 plots of equal size.



4 Boxes Oranges with no Fertilizer.	9 Boxes Oranges Fertilized with Acid Phosphate Alone.	15 Boxes Oranges Fertilized with Nitrate of Soda and Acid Phosphate.

Formulas for full-grown citrus trees in tabular form are as follows:

	Rate per Acre
Nitrate of Soda alone..........................	200 lbs.
or preferably	
Nitrate of Soda	400 lbs.
Acid, or Super Phosphate......................	400 lbs.

These formulas it is believed will also be found very satisfactory for both full-grown lemon trees and full-grown grapefruit.

How It Was Done at Corona, California.

The rows were trenched eight inches deep, just outside the drip of the trees and the fertilizers spread in the trench opposite the whole width of each tree. This was done on two sides of each row in the same direction, then covered by the plow. This, the only plowing, was done on March 7, 1918. The application of fertilizers in trenches is found to give the best results in the orange groves of this section.

Six after-cultivations to a depth of five or six inches were given. These six cultivations were made during the

Results at Corona.

32.2 Boxes Oranges. Yield of 1/10 acre fertilized with Acid Phosphate alone.

41.1 Boxes Oranges. Yield of 1/10 acre fertilized with Nitrate of Soda and Acid Phosphate.

forepart of each of the months of March, April, May, June, July and August. The March cultivation consisted of a thorough disking. The other five cultivations were made with the ordinary orchard cultivator.

The above trench fertilizing was done parallel with irrigation furrows up one side and down the other, noth-

ing being applied on the other two sides. This has given good results and the above method is recommended to California citrus fruit growers.

Citrus Growing in California.

A five-sixteenths of an acre plot of orange trees at Corona fertilized with Nitrate of Soda and acid phosphate at the rate of 320 pounds of each per acre yielded at the rate of 411 boxes of high quality fruit. A plot alongside fertilized without Nitrate gave a rate of yield of only 322 boxes per acre of inferior fruit. *This difference of yield of 89 boxes per acre due to the use of Nitrate shows an increase in value of produce equivalent to* $324.85. Each 100 pounds of Nitrate of Soda used in this case added a rate of profit to the grower's income of $101.52 per acre.

The best source of Nitrogen for citrus fruits is Nitrate of Soda, because of its instant availability. Growth is promoted at once after application is made. It is taking chances to apply any nitrogenous fertilizer not immediately available because of the tendency to prolong growth unduly and to delay maturity; and it is fatal to apply high grade fertilizers too late. In California on alkaline soils or soils having alkaline tendencies the application of Nitrate of Soda with an equal quantity of acid phosphate or super phosphate tends to diminish black alkali present.

The Rational Use of Chilean Nitrate in California.

The use of Chilean Nitrate is increasing year by year in England, and it is coming to be more and more appreciated there, as well as on the continent of Europe.

In fact, everywhere in the world where there is progressive and enlightened experiment work, the unique qualities of Chilean Nitrate are putting it ahead of every other nitrogenous plant food. No reputable authority in the world has ever advocated such large quantities of

Chilean Nitrate per acre as would result in any abnormal accumulation of alkali. Moreover, the use of acid phosphates, associated as they are commercially with sulphate of lime, converts any black alkali residue into harmless forms of soda. The vast majority of soils in the United States, probably 95 per cent., have a tendency to grow acid rather than to grow alkali; and Chilean Nitrate is, therefore, highly beneficial in such cases.

The use of potash salts tends to leave acid residuals, and when phosphates and potashes are used rationally, and in quantities suitable for normal plant feeding, the question of Chilean Nitrate leaving abnormal amounts of alkali residues becomes a purely fanciful one, and is not worthy of the serious attention of a practical business horticulturist or farmer.

In all our literature, the rational and not the irrational use of fertilizers is recommended, *i. e.*, normal amounts of the three elements of fertility. The use of Chilean Nitrate alone is not recommended except at the rate of 100 or 200 pounds per acre, which is a trifling tonnage application; and we always advise when larger amounts are used, that the horticulturist or farmer use as much in quantity of acid phosphate.

The vast majority of farm lands of our country, where so-called " Complete " fertilizers have been used, have the tendency to become sour and acid; and Chilean Nitrate could not only be used indefinitely with an extremely beneficial effect in this particular connection, but there is an immediate general need for it.

An acre of ground one foot deep is the active service part of the soil, and, to a large extent, its chemical composition determines its usefulness. This service soil weighs on an average 2,000 tons per acre.

There is enough sulphate of lime or gypsum present, as well as acid, in the average acid phosphate, to materially help the black alkali of many alkaline soils, but gypsum alone may be used also for correcting alkali.

Since we never recommend the use of Chilean Nitrate alone, except at the rate of from one hundred to two hun-

dred pounds per acre, this relatively small amount could have no material influence whatever in increasing the alkali content of soils. The continued use of Nitrate under rational methods of fertilizing, would not add to, but rather diminish the quantity of alkali in the soil. The associated gypsum and acid phosphate thus used would tend to loosen heavy clay soils which need improvement in texture and the acid residues from these materials would likewise benefit alkaline soils.

In this connection, it is important to observe that care must be exercised, in soils containing black alkali, to avoid materially increasing the content of carbonate or bi-carbonate of lime, since this would help promote the destruction of humus. It is, therefore, suggested for these particular soils, that the large and constant use of lime be avoided. When lime is needed, have your soil examined by an expert, and do not put on any more lime in any form than advised for your particular case. In other words, take good care to preserve your humus. Do not destroy it by excessive liming on any account. Neither wetness nor stickiness will result from the rational use of Chilean Nitrate. The productivity of all soils may be increased by the right use of it.

All arid soils lack nitrogen on account of having but little natural humus in them, hence the application of Chilean Nitrate should give profitable crop increases.

What Burbank Says:

"After testing a great variety of fertilizers on my orchard and experimental grounds, I find that the Nitrate of Soda and Thomas slag phosphate have given the best results at the least expense, and I shall not look further at present, as my trees, bulbs, plants, flowers and fruits have been, by the use of about 150 pounds each per acre, nearly doubled in size and beauty in almost every instance. The above-named fertilizers have more than doubled the product of my soil at a very small outlay per acre.

Where the Nitrate of Soda is used, I find a greatly increased ability in trees to resist drought, and lack of cultivation."

"Luther Burbank is the greatest originator of new and valuable forms of plant life of this or any other age," says David Starr Jordan, President of Leland Stanford Junior University, California.

WINTER SPRAYING WITH SOLUTIONS OF NITRATE OF SODA.

By W. S. BALLARD, *Pathologist, Fruit-Disease Investigations, Bureau of Plant Industry,* and W. H. VOLCK, *County Horticultural Commissioner of Santa Cruz County, California.*

These investigations were conducted in co-operation between the Office of Fruit-Disease Investigations of the Bureau of Plant Industry and the office of the County Horticultural Commissioner of Santa Cruz County, located at Watsonville, Cal.

Introduction.

Recently several investigators have reported results in shortening the rest period of a number of woody plants by immersing the dormant shoots in weak nutrient solutions or by injecting solutions of alcohol, ether, and various acids into the twigs. These experiments have been conducted in the laboratory with short cuttings of the plants. The effect of such treatment has been to force the dormant buds out several days ahead of the normal opening period.

During the last two years the writers have obtained similar and additional results on a much larger scale by spraying dormant fruit trees with strong solutions of certain commercial fertilizers, especially Nitrate of Soda. Since these experiments have been conducted on the entire trees in the orchard, it has been possible to observe the effects throughout the whole season. The investigations have not yet been carried far enough to permit drawing any conclusions regarding the physiologic action of such spraying, but because of its practical value these preliminary results seem deserving of attention at this time.

Experiments in 1912.

In the course of the investigations of the writers on the control of apple powdery mildew in the Pajaro Valley, Cal., it became evident that the general vigor of the tree and the thriftiness of the foliage growth had much to do with the success of the summer spraying treatment for the control of the mildew, and after a number of experiments in applying plant-food materials to the foliage in the form of summer sprays, and after seeing that certain crude-oil emulsions used as dormant sprays had a marked effect in stimulating an increased vigor of the trees the following spring, it was decided to try the effect of a strong solution of Nitrate of Soda as a winter or dormant spray. Caustic potash (potash lye) was also added for the purpose of giving the spray an insecticide value. The mixture was prepared according to the following formula:

Nitrate of Soda	50 pounds
Caustic Potash	7 pounds
Water	50 gallons

The experiment was conducted in a Yellow Bellflower apple orchard owned by Mr. O. D. Stoesser, of Watsonville, Cal. This orchard is situated about 5 miles from the ocean shore and is in a district that is more subject to ocean fogs and trade winds than is the main portion of the Pajaro Valley. It is a common characteristic of the numerous orchards of Yellow Bellflower apples of this particular district that they bloom abundantly, but set only a partial crop. The trees are on a deep sedimentary soil and grow well.

Seven 12-year-old trees were sprayed on February 2, 1912. The application was very thoroughly made, so that all of the small twigs were drenched. About 7 gallons of spray solution were applied to each tree. Adjoining this row on one side was a check row of seven trees which received no winter spraying, and on the other side were several rows of seven trees each which received various applications of crude-oil emulsions and soaps. For the purpose of gaining some idea of the effect of

Nitrate of Soda used as a fertilizer, 50 pounds were applied as a surface dressing to one vigorous tree selected from the row adjoining the Nitrate-sprayed row. This fertilizer was later plowed in and washed down by the rains.

Effects on Blossoming and on the Foliage.

Notes taken at the time the trees were coming out in the spring show the following results:

April 7, 1912. Trees in the row sprayed with Nitrate of Soda and lye are well in bloom, while those in the check row adjoining and in the remainder of the unsprayed orchard are showing only an occasional flower fully opened.

April 14, 1912. The relative advancement of the row sprayed with a solution of Nitrate of Soda and lye and the check plat is the same as noted on April 7. The Nitrate-sprayed trees are nearly in full bloom, whereas comparatively few blossoms have opened on the check plat.

When the check row had reached full bloom, the row sprayed with a solution of Nitrate of Soda and lye was practically out of bloom.

Thus, the Nitrate spraying advanced the blossoming time about two weeks ahead of the normal period. It is characteristic of the Yellow Bellflower variety of apples in the Pajaro Valley that the foliage buds come out early, so that by the time the full-bloom period is reached the trees are showing a considerable amount of young foliage. The Nitrate spraying produced a change in this respect. While the flower buds were greatly stimulated in coming out, the foliage buds were not so much affected, and the result was that when the trees sprayed with a solution of Nitrate of Soda and lye were in full bloom and two weeks in advance of the check trees in that regard, their foliage condition was relatively nearer that of the check. Plate L shows the comparative stages of the Nitrate-sprayed and the check trees at that time. A decided contrast will be seen in the relative advancement of the bloom on the tree sprayed with Nitrate of Soda (Pl. L, fig. 1)* as compared with the check tree (Pl. L, fig. 2).* This contrast is shown more in detail in Plate LI, in which figure 1 shows a branch from a Nitrate-sprayed tree, while

* For plates see original article.

figure 2 shows one from a check tree. Both branches were collected on the same day. An examination of the figures in Plate L will show that the advancement of the foliage on the Nitrate-sprayed tree is comparatively less marked than that of the bloom. This same condition is shown in detail in Plate LI, in which it will be seen that there is relatively little difference in the advancement of the foliage of the sprayed and unsprayed branches. Later in the spring, however, the effect on foliage growth became more pronounced, and the sprayed trees assumed a more vigorous, green appearance than the check trees. The single tree that received the 50 pounds of Nitrate of Soda applied to the soil showed no greater vigor than the check trees.

Both the row sprayed with Nitrate of Soda and the check row received summer sprayings directed toward the control of apple powdery mildew and of codling moth and various other insect pests. While the treatment of the two rows was not the same, there was no essential difference in the results — that is, the crop loss from codling moth and other insect pests did not exceed 1 per cent. on either plat and there was no damage to the fruit from summer spraying. It is therefore, evident that the difference which showed up in the crop production of the two rows must be attributed to the winter Nitrate spraying.

Crop Results.

The check row of seven trees, which received no winter spraying but which was properly protected by summer sprayings, produced 8 loose boxes of fruit at picking time. On the other hand, the adjoining row, sprayed in February with the solution of Nitrate of Soda plus lye, produced a total of a little over 40 boxes. Thus, the winter Nitrate spraying increased the crop production to fully five times that of the unsprayed row. Similar adjacent plats, which were winter-sprayed with various crude-oil emulsions and soap sprays, produced crops varying from 5 to 9 boxes

per plat. The single tree which received the 50 pounds of Nitrate of Soda applied as a fertilizer gave no increased production, whereas none of the trees in the Nitrate-sprayed row failed to respond.

Regarding the single, heavily fertilized tree, it might be stated that in addition to its showing no increase in production, the tree bloomed no earlier than normal, there was no improvement in the growth and no change in its general appearance throughout the growing season of 1912, and in the spring of 1913 it came out normally and not differently from the other trees in the same row, being one of the trees in a check plat. The tree is still in normal condition and shows no noticeable effect from the heavy fertilizing. The orchard is not irrigated, and the rainfall has been much less than normal during the last two years.

Attention might again be called to the conditions under which these results were obtained — namely, thrifty-growing trees in a deep residual soil and having the characteristic of blooming abundantly each year but setting only a shy crop. Even the 40 boxes produced by the Nitrate spraying does not represent the full crop that such trees should bear, but the fourfold increase much more than paid for the cost of spraying, and the possibility remains of still further increasing that production by similar treatment in following years.

Experiments in 1913.

The one small experiment on seven trees in 1912 did not furnish sufficient grounds for drawing any general conclusions as to the applicability of winter Nitrate spraying, but the striking results obtained opened a wide field of inquiry. For instance, potash lye was added to the solution of Nitrate of Soda in the experiment of 1912, so the questions arise as to whether the lye was necessary and whether an acid medium would increase or decrease the effect of the Nitrate of Soda; also, would a weaker Nitrate solution prove as effective and would other nitrogen-bearing fertilizer materials,

such as lime Nitrate, lime cyanamid, and sulphate of ammonia, give similar results? Following along this line it would be interesting to know what effect, if any, the other fertilizer elements, potash and phosphoric acid, might have when applied as sprays, and finally, what results might be obtained from a similar application of other substances not ordinarily considered as having any particular fertilizer value.

Experiments intended to answer these and a number of other more or less important questions were started in February, 1913, in the same orchard in which the previous year's work was done. Eleven 13-year-old trees were used in each plat. A frost occurred at the time the fruit was setting which ruined the crop and made it impossible to obtain results in crop production. Data were obtained, however, on the effect of the various sprays on the blossoming of the trees in the spring, and the notes taken may be summarized as follows:

The plats sprayed with Nitrate of Soda at the rate of 1 pound to the gallon came into bloom earlier than the check trees, just as they had done in 1912. This effect was more marked in the cases in which lye was added to the Nitrate solution than when the plain water solution was used — that is, the addition of lye in the proportion of 16 pounds of caustic soda in 100 gallons of spray solution increased the action of the Nitrate of Soda in bringing the trees out earlier. Caustic soda appeared to be just as effective as caustic potash. Nitrate of Soda used at the rate of half a pound to the gallon, either with or without the addition of lye, was not nearly so effective as a solution of 1 pound to the gallon. A solution of one-fourth of a pound to the gallon, with lye added, had practically no effect. Nitrate of Soda, at the rate of 1 pound to the gallon, to which oxalic acid was added in the proportion of 50 pounds to 125 gallons of solution, produced results similar to Nitrate of Soda plus lye, so far as the effect of hastening the blooming period is concerned. Lime Nitrate, 130

pounds in 100 gallons of water, and lime cyanamid, 92 pounds in 100 gallons of water, stimulated an earlier blooming of the trees, and subsequent experiments will probably put these substances in a class with Nitrate of Soda. Normal Yellow Bellflower apple blossoms have considerable pink color, and it was interesting to note that when the trees sprayed with the lime cyanamid came into bloom the flowers were nearly white. The effects from sulphate of ammonia were not nearly so marked as those from Nitrate of Soda. These various nitrogen-bearing fertilizer substances were used in such strengths as to carry relatively the same quantities of nitrogen per gallon. Sulphate of potash had some effect in stimulating an early blooming, but double superphosphate did not. Of a number of other substances tried, common salt used at the rate of 68 pounds to 100 gallons of water produced a distinct effect.

It will be borne in mind that the above remarks apply simply to the effects of the various sprays in causing an earlier blooming of the trees, but since this early blooming was a striking characteristic of the Nitrate-sprayed trees of 1912, which showed a fourfold increase in production, it seems permissible to conclude that this effect on the fruit buds is some criterion of what might have been expected in the way of crop increase had not the fruit been lost by frost.

The row of seven trees used in the Nitrate experiment of 1912 was left unsprayed this last season for the purpose of determining whether the Nitrate effect would continue to the second year. It was noticed that the fruit buds on these trees were particularly large and plump, and somewhat unexpectedly at blossoming time these trees came into bloom several days ahead of the check rows. The bloom came out very uniformly all over the trees, whereas ordinarily it is considerably delayed on the windward side. Also, the individual blossoms were conspicuously larger than those of any other plat, and, so far as could be judged at the time the frost occurred, a good crop was setting all over the trees.

Thus, it appears that this effect of the Nitrate of Soda had continued over to the second year.

At present, all things considered, the best results have been obtained by using a mixture made up as follows:

Nitrate of Soda	200 pounds
Caustic Soda	25 pounds
Water	200 gallons

In preparing this solution the required quantity of water was placed in the spray tank and the agitator started. When the water was in motion, the required weight of Nitrate of Soda was added gradually. Any large lumps were first broken up into pieces about the size of hen's eggs. The caustic soda was then added, and in about 15 minutes from the time the preparation was begun the mixture was ready for applying.

The trees were very thoroughly sprayed on all sides, so that all of the small twigs were drenched. The best results so far obtained have come from the spraying applied about the 1st of February. Of course, weather conditions must be taken into consideration. A rain immediately following the application will wash much of the material off of the trees, and it is probable that at least a week of clear weather should follow the spraying, in order to insure good results.

In all of this work on spraying a solution of Nitrate of Soda on the trees a considerable quantity fell to the ground, and the question will be raised as to whether the various effects observed have not been simply the result of the fertilizer action of the Nitrate on the soil. About 7 gallons of the solution were used in spraying each tree, and if the whole of this had gone on the ground it would have amounted to about 7 pounds of Nitrate of Soda per tree. The single tree in 1912 that had the 50 pounds of Nitrate applied to the soil, therefore, received over seven times the total quantity applied to any single sprayed tree. As has been previously stated, this single, excessively fertilized tree bloomed no earlier than normal, produced no increased crop, and showed no

improvement in general vigor and appearance; whereas, none of the trees in the sprayed plat failed to respond in all of these particulars. Of course, this single tree test in the application of Nitrate to the soil is too small an experiment to permit concluding positively that the effects that we have reported from the spraying experiments are of an entirely different nature and belong in a different category from those produced by the ordinary soil application of Nitrate. A careful consideration of the results of ordinary orchard practice in fertilizing seems to make it plain that there is no similarity between them and the results from spraying. For instance, in the usual practice of applying Nitrate of Soda as a fertilizer to apple orchards in the region of Watsonville, Cal., a winter or early spring application does not force the bloom out 10 days or 2 weeks ahead of the normal opening period and has had no measurable effect in increasing the set of fruit that same year. The fact that the addition of caustic soda or oxalic acid to the Nitrate spray augments these various effects further emphasizes the difference between the results from spraying and the ordinary results from the application of fertilizer. Caustic-soda solution alone applied as a spray has no effect on the time of blooming or the crop production.

EXPERIMENTS OF GROWERS IN 1913.

Yellow Bellflower Apples.

During the past season a number of growers made more or less extensive tests of the spraying with Nitrate of Soda. An aggregate of several hundred acres of Yellow Bellflower apples was sprayed with Nitrate of Soda plus caustic soda, but practically all of this acreage was in the same district in which the writer's experiments were conducted, so the crop was lost by frost. It was noticeable during the past summer, however, that the foliage in such orchards as received very thorough winter Nitrate sprayings had a better appearance than in years past, due apparently to the effect of the Nitrate.

One orchard, that of MacDonald & Sons, is located in a district that practically escaped frost damage, and the results obtained indicated a marked crop increase in consequence of the spraying. The entire orchard, with the exception of a few trees, was sprayed with various combinations of Nitrate of Soda and lye, and, while no exact data on the production of the unsprayed trees as compared with the rest of the orchard was obtained, the amount of fruit on the trees indicated that the spraying had produced a marked increase. This conclusion was more reliably substantiated by comparing the total orchard production this year with that of previous years.

Sweet Cherries.

Mr. A. W. Taite, of Watsonville, sprayed portions of two blocks of Napoleon (Royal Ann) cherries with Nitrate of Soda, 1 pound to the gallon, to which caustic soda was added at the rate of 25 pounds to 200 gallons. Unsprayed rows adjoining the sprayed ones were left in each block. In one case the sprayed trees were distinctly advanced over the check trees in coming into bloom. In both cases there was an increase in the foliage growth and a consequent improvement in the appearance of the trees. No effect on crop production could be noticed, though it is possible that treatment in successive years may bring such results.

Pears.

For our observation on pears the writers are indebted chiefly to Mr. George Reed, of San Jose, who carried out extensive tests in the orchards of the J. Z. & G. H. Anderson Fruit Co. The spraying was done about the 1st of February and the following notes are taken largely from Mr. Reed's observations:

CLAIRGEAU.— Four rows of about 40 trees each were sprayed with commercial lime-sulphur (33% Baume) diluted 1 to 9. Adjoining these were four rows sprayed with lime-sulphur solution diluted 1 to 9 and to which was added Nitrate of Soda at the rate of 1 pound to the gallon of the diluted spray. The rows sprayed with the combined solution

of Nitrate of Soda and lime-sulphur came into bloom about a week ahead of those that received the lime-sulphur solution alone. The development of the fruit on these Nitrate-lime-sulphur solution rows continued to show an advancement of about a week throughout half the growing season, and at picking time the fruit was greener and hung on better than that of the plain lime-sulphur-solution rows. Both plats bore a full crop, so there was no opportunity for observing any effect on production. The Clairgeau variety blooms early, and the further advancement due to Nitrate spraying might result in frost injury in some localities. The fruit ordinarily has a habit of dropping off during the latter part of the growing season. This difficulty, however, was largely eliminated on the Nitrate-sprayed rows.

COMICE.— The major portion of the block was sprayed with a plain water solution of Nitrate of Soda at the rate of 1 pound to the gallon. A small portion was sprayed with commercial lime-sulphur solution, diluted 1 to 9, with Nitrate of Soda added at the rate of 1 pound to the gallon of diluted spray. Through a misunderstanding the men doing the spraying left no check rows in this block, so that crop data could not be obtained. However, Mr. Reed's exact knowledge of the previous production of this block as a whole indicates that the marked increased production this last season was more than probably due to the Nitrate spraying. The Comice is a relatively shy bearer, and a valuable pear commercially, so that any increased production that could be obtained by Nitrate spraying would be much appreciated by the grower. One portion of the block that regularly produces less than the remainder gave a good crop this year, and it appeared that the addition of the lime-sulphur solution augmented the effect of the Nitrate of Soda just as the addition of lye has done in the experiments of the writers.

GLOUT MORCEAU.—A block of Glout Morceau pears was sprayed with the combination of lime-sulphur solution, diluted 1 to 9, plus Nitrate of Soda 1 pound to the gallon of diluted spray. This block had never produced a full crop, and while no unsprayed checks were left, the increased production would appear to be due to the Nitrate spraying.

WINTER NELIS.—A block of Winter Nelis pears was sprayed with a solution of Nitrate of Soda 1 pound to the gallon of water. No lime-sulphur solution was added in this case. No check rows were left, and a frost destroyed a large percentage of the fruit after it had set. How ever, at that time the trees were carrying the largest crop they had ever produced, and again it would appear that the Nitrate spraying had had a beneficial effect. The trees came into bloom about 10 days ahead of normal opening period.

Discussion on Results and Summary.

It is not the writers' intention to convey the impression that dormant spraying with Nitrate solutions will solve the problem of shy bearing of fruit trees nor

offer a more advisable method of applying nitrogen fertilizer. The purpose of this paper is simply to present the results as they now stand.

It is evident that, at least under certain conditions, some varieties of apples and pears that are more or less self-sterile may have their crop production materially increased by dormant spraying with solutions of Nitrate of Soda plus lye. The combination of a solution of Nitrate of Soda and lime-sulphur is apparently capable of bringing similar results.

Actual quantitative data on increased production from spraying with a solution of Nitrate of Soda are available from only one source, that of the first experiment on Yellow Bellflower apples in 1912. No production records were obtainable from the various tests made by growers during the season of 1913 but the one test on Yellow Bellflower apples and several others on pears indicate that such an increase had undoubtedly been brought about. It is considered that the growers' knowledge of the crops of the previous years as compared with that of this year furnishes a basis for conclusions that are at least corroborative.

That Nitrate spraying of dormant trees will bring about an earlier blooming of certain varieties of fruit is a satisfactorily established fact, which has been demonstrated on Yellow Bellflower apples at Watsonville, Cal, and on various varieties of pears at San Jose, San Juan, and Suisun, Cal., during the past season. How generally this statement will apply to other varieties of apples and pears and in other localities remains to be determined. Results on stone fruits have not been as striking as those on pears and apples, but it is possible that stronger solutions, earlier spraying, or a repetition of the spraying in successive years may bring about such results.

The greater danger of injury from frost that might result from forcing trees into bloom earlier than normal would have to be taken into consideration in making practical use of Nitrate spraying in winter.

Aside from the effect on crop production, there has also been a very noticeable improvement in the color, abundance, and vigor of the foliage, and it seems possible that Nitrate spraying of dormant trees may be a valuable supplement to the ordinary fertilizer practices in obtaining quick results in orchards suffering from lack of nitrogen.

The writers will make no attempt at present to explain the peculiar effect of Nitrate of Soda in increasing the production of more or less self-sterile varieties of fruits, or in improving foliage growth. The similarity between the writers' results in forcing dormant buds by winter Nitrate spraying and the results obtained by other investigators by treating cuttings with various weak solutions has been mentioned. In experiments of the writers, however, a more or less lasting effect on the vigor of the foliage and also some valuable results in increasing crop production have been obtained. It furthermore appears that the effects obtained by spraying with a solution of Nitrate of Soda may continue over to the second year, as shown by the original plat of 1912, which was left unsprayed in the winter of 1913.

The effects of the Nitrate spraying seem to be proportional to the strength of the solution employed and the thoroughness with which it is applied. The addition of caustic soda materially increases this action.

Plant Food Withdrawn by Crops.

The New York, the New Jersey, and the Connecticut Experiment Stations agree that the relative percentages of plant food withdrawn from the soil by barley, buckwheat, corn, oats, rye, and wheat are as follows:

	Phosphoric Acid per cent.	Nitrogen per cent.	Potash per cent.
Barley	20.0	44.6	35.4
Buckwheat	33.3	52.5	14.2
Corn	17.7	37.5	44.8
Oats	15.9	40.5	43.6
Rye	21.3	42.0	36.7
Wheat	21.0	51.9	27.1

The average relative percentages of phosphoric acid, Nitrogen and potash thus removed from the soil by these six staple cereals is therefore as follows:

Phosphoric Acid	21.5 per cent.
Nitrogen	44.8 per cent.
Potash	33.6 per cent.

Translated into Commercial Fertilizer terms, the comparison is as follows:

	What Nature Requires	What the Average Brand Supplies
Phosphoric Acid	2.15	8.00
Nitrogen	4.48	2.00
Potash	3.36	2.00

POINTS FOR CONSIDERATION AS TO RELATION OF PRICES OF FARM PRODUCTS TO NITRATE OF SODA PRICES.

From the farmer's point of view, when a reduction in the price of cotton and produce happens, it is to be deplored, but in such a case it should be considered whether abstention from the use of Nitrate is a wise way of meeting the situation. The utility of a fertilizer obviously depends upon its productivity, which is not affected by its price, and an increase in the latter justifies abandonment of the fertilizer only when its productivity ceases to be profitable. The profit to be reasonably expected from the use of Nitrate of Soda is not so materially interfered with by any ordinary rise in its price as to economically justify any substantial reduction in its consumption.

What Nitrate Has Done for Crops.

Agricultural authorities have established by careful experimentation that 100 pounds of Nitrate of Soda when applied to the following crops has produced under proper conditions *increased* yields as tabulated:

Apples	50–75 bushels.
Apricots	96 lbs.
Asparagus	100 bunches.
Bananas	1,167 lbs.
Barley	400 lbs. of grain.
Beans (white)	225 lbs.
Beets	4,900 lbs. tubers.
Cabbages	6,100 lbs.
Carrots	7,800 lbs.
Castor Beans	50 lbs.
Celery	30 per cent.
Corn	280 lbs. of grain.
Cotton	500 lbs. seed cotton.
Ensilage Corn	1.18 tons.
Grape Fruit	29 boxes.
Hay, upwards of	1,000 lbs. barn cured.
Hops	100 lbs.
Mangels	123.7 bushels.
Oats	400 lbs. of grain.
Onions	1,800 lbs.
Oranges	22 boxes.
Peaches (dried)	56 lbs.
Pecans	37 lbs.
Potatoes	3,600 lbs. tubers.
Prunes	975 lbs. (dried).
Raisin Grapes	347 lbs.
Rye	300 lbs. grain.
Strawberries	200 quarts.
Sugar Beets	1,330 lbs.
Sugar Cane	2.40 tons of cane (Tropics). 1.17 tons of cane (Louisiana).
Sugar (from Sugar Cane)	322 lbs. (Tropics). 224 lbs. (Louisiana).
Sugar Mangels	1.6 tons.
Sweet Potatoes	3,900 lbs. tubers.
Tobacco	75 lbs.
Tomatoes	100 baskets.
Turnips	37 per cent.
Walnuts	106 lbs.

Increased Yield by the Use of Nitrate of Soda.

The increased yields of crops resulting from a top-dressing with Nitrate of Soda are most striking. In an article recently published by Dr. E. J. Russell, Director of the Rothamsted Experimental Station, the following figures are given. On an ordinary farm where the land, while in fairly good heart, has not been over

well done, a farmer may reasonably expect the following increases from a top-dressing of 1 cwt. of Nitrate of Soda:

	Per 1 cwt. nitrate of soda.	Per 1 cwt. superphosphate or high grade basic slag.
Wheat, grain	4½ bushels	0 to 1¼ bushels.
Wheat, straw	5 cwt.	½ to 5 cwt.
Barley, grain	6½ bushels	2 to 3 bushels.
Barley, straw	6¼ cwt.	0 to 2 cwt.
Oats, grain	7 bushels	1 to 3½ bushels.
Oats, straw	6 cwt.	0 to 2 cwt.
Hay	8 to 10 cwt.	——
Mangolds	32 cwt.	20 cwt.
Swedes	20 cwt.	20 to 40 cwt.
Potatoes	20 cwt.	10 cwt.

For purposes of comparison the effect of phosphates is shown also.

Official Abstract of a Paper read by Professor E. B. Voorhees before The International Congress of Applied Chemistry held in London, June, 1909.

INVESTIGATIONS RELATIVE TO THE USE OF NITROGENOUS FERTILIZER MATERIALS, 1898–1907.

By EDWARD B. VOORHEES, SC. D. (*Director*) and JACOB G. LIPMAN, PH. D. (*Soil Chemist and Bacteriologist*), *Agricultural Experiment Station, New Jersey, U. S. A.*

Ten years ago denitrification was believed to possess an economic significance. A considerable number of agricultural chemists thought that the destruction of nitrate by denitrifying bacteria involved losses of nitrogen in all cases where nitrates and animal manures were used together. The experiments recorded here were planned, primarily, to determine whether such losses of nitrogen really occur in field practice. The data collected in the course of ten years supply some definite information in this connection; and furnish, moreover, much important information bearing on other phases of the nitrogen question.

The experiments have been carried on in large galvanized iron cylinders 4 feet long, 23.5 inches in diameter, and open at both ends. The cylinders were sunk in the ground until only about 2 inches of the upper portion projected above the level of the surrounding soil. Uniform amounts of gravelly subsoil were placed in the cylinders and firmly tramped down. Weighed quantities of surface soil were then placed in the cylinders. In order to enhance the accuracy of the data collected, each treatment was carried out in triplicate. There were secured thus 20 series, each consisting of three small plats. Series 1 has received no applications whatsoever; series 2, applications of acid phosphate and potassium chloride repeated annually; and the remaining series various nitrogenous materials in addition to the acid phosphate and potassium chloride. Also the nitrogenous materials have since been applied annually. The following diagram shows the treatment for each series:

Diagram of Experiment

Series		A	B	C
1.	Check	0	0	0
2.	Minerals	0	0	0
3.	Manure, solid, fresh	0	0	0
4.	Manure, sold and liquid, fresh	0	0	0
5.	Manure, solid, leached	0	0	0
6.	Manure, solid and liquid, leached	0	0	0
7.	Sodium Nitrate, 5 gms	0	0	0
8.	Sodium Nitrate, 10 gms	0	0	0
9.	Manure, solid, fresh; nitrate, 5 gms	0	0	0
10.	Manure, solid, fresh; nitrate, 10 gms	0	0	0
11.	Manure, solid and liquid, fresh; nitrate, 5 gms	0	0	0
12.	Manure, solid and liquid, fresh; nitrate, 10 gms	0	0	0
13.	Manure, solid, leached; nitrate, 5 gms	0	0	0
14.	Manure, solid, leached; nitrate, 10 gms	0	0	0
15.	Manure, solid and liquid, leached; nitrate, 5 gms	0	0	0
16.	Manure, solid and liquid, leached; nitrate, 10 gms	0	0	0
17.	Ammonium sulphate	0	0	0
18.	Dried blood	0	0	0
19.	Manure, solid, leached; ammonium sulphate	0	0	0
20.	Manure, solid, leached; dried blood	0	0	0

The nitrate was applied at the rate of 160 pounds and 320 pounds per acre, respectively. The ammonium sulphate and dried blood were applied in amounts equivalent

to the larger application of nitrate. The different manures were applied in amounts sufficient to furnish about 4 gms. of nitrogen per cylinder. Calculated on the acre basis the manures were applied at the rate of about 16 tons.

The crops were grown in regular rotation, and consisted of the following: Corn, oats, wheat and timothy. The oats crops were followed in each case by a so-called residual crop whose function it was to take up such available nitrogen compounds as were not utilized by the main crops.

Analyses were made of all of the main crops and residual crops. In the case of the wheat, the grain and the straw were analyzed separately. In the case of the timothy, the first cutting and aftermath were analyzed separately. The analytical material for the ten years included, therefore, more than a thousand crop samples. Records were made of the yields of dry matter, of the proportions of nitrogen in the dry matter of each crop, of the total nitrogen in each crop, of the proportion of manure and fertilizer nitrogen recovered, and of the relative availability of the several nitrogenous materials employed. In addition to these careful analyses were made of the soil samples drawn from the several cylinders at the end of each rotation.

The results secured may be briefly summarized as follows:

1. There was a marked falling off in the yields between the first and second rotation, especially in the soils which had received no applications of animal manure.

2. The nitrogen compounds in liquid manure were much superior to those in solid manure as a source of nitrogen to crops.

3. Larger applications of nitrogen were invariably followed by larger yields of this constituent in the crops.

4. Nitrate, ammonium sulphate and dried blood, when applied in equivalent amounts, were found to possess an unequal value. Nitrate was superior to ammonium sul-

phate, and the latter was superior to dried blood as a source of nitrogen to crops.

5. In the presence of nitrate, the manure and humus nitrogen were utilized more thoroughly than in its absence.

6. Under certain conditions, nitrates or other readily available nitrogen compounds, may hasten the depletion of the soil nitrogen.

7. Ammonium sulphate and dried blood intensified the development of acidity in the cylinder soils.

8. The proportion of nitrogen in the crops was readily affected by the nitrogen treatment. It was also affected by the character of the crop itself.

9. In the first rotation, the fresh manures produced dry matter relatively somewhat richer in nitrogen than that produced by the leached manures; in the second rotation this relation was reversed.

10. The solid and liquid manure, fresh, produced dry matter relatively somewhat richer in nitrogen than that produced by the solid, fresh.

11. The smaller application of nitrate, when used together with manure, produced dry matter relatively poorer in nitrogen than that produced by the larger application of nitrate under the same conditions.

12. The wide range in the proportionate content of nitrogen in the crops, shows clearly that greater care should be exercised in measuring out the nitrogen to our cultivated crops.

13. Out of every 100 pounds of nitrogen applied in the form of nitrate, there were recovered in the first rotation 62.76 pounds, and in the second rotation 61.42 pounds. The corresponding returns for ammonium sulphate were 49.51 pounds and 37.01 pounds respectively; and for the dried blood 47.89 pounds and 32.05 pounds respectively. This indicated that the acidity in the soils of series 17 and 18 had increased sufficiently to interfere with the normal growth of the plants.

14. Out of every 100 pounds of nitrogen applied in the form of animal manures, there were recovered in the

first rotation less than 25 pounds, and in the second rotation less than 30 pounds.

15. A comparison of the crop yields in the first and second rotation, shows that the animal manures have a marked cumulative effect.

16. The corn crops seem to have utilized a smaller proportion of the nitrogen applied than was utilized by the oats and wheat.

17. The fresh manures were utilized better than the leached manures.

18. The solid and liquid, fresh, was utilized better than the solid, fresh.

19. The solid and liquid, leached, was utilized better than the solid, leached.

20. The smaller applications of nitrate were utilized to about the same extent as the larger applications.

21. The equivalent quantities of nitrate, ammonium sulphate, and dried blood were utilized in the order named.

22. The animal manures when used together with the larger applications of nitrate, were utilized to better advantage than when they were used together with the smaller application.

23. The nitrate and ammonium sulphate when used together with solid manure, leached, were utilized in the order named.

24. The proportion of nitrogen recovered in the crops ranged from 62.09 — 22.31 per cent.

25. With the returns from the nitrate nitrogen taken as 100, the relative availability of the other nitrogenous materials was as follows:

	First Rotation	Second Rotation	Both Rotations
Sodium nitrate	100.0	100.0	100.00
Ammonium sulphate	78.9	60.3	69.7
Dried blood	76.3	52.2	64.4
Solid manure, fresh	32.9	39.0	35.9
Solid and liquid, fresh.......	50.4	55.6	53.0
Solid manure, leached	33.8	44.0	38.9
Solid and liquid, leached.....	36.6	49.7	43.1

26. Nitrate, and ammonium sulphate showed practically no residual effect. Dried blood showed a slight residual effect.

27. The animal manures showed a very pronounced residual effect.

28. Notwithstanding the annually repeated applications of manure, together with relatively large amounts of nitrate, there is no marked evidence of denitrification.

29. All of the cylinder soils lost considerable quantities of nitrogen.

TWENTY YEARS' WORK ON THE AVAILABILITY OF NITROGEN IN NITRATE OF SODA, AMMONIUM SULFATE, DRIED BLOOD AND FARM MANURES.

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(Reprinted from "Soil Science.")

During the last twenty-five years the fertilizer industry in the United States has developed rapidly. From a comparatively small tonnage in the early nineties it has grown to more than 7,000,000 tons in 1917.

As the industry has grown the number of materials that go to make up the fertilizers has also increased greatly. Many by-products that were formerly allowed to go to waste are now carefully saved and worked up in the fertilizer factory This is especially true of the nitrogenous materials which, under normal conditions, form the most expensive part of the fertilizer.

The movement to save these waste materials containing nitrogen came none too early, for it was the depletion in the soil of this element that was largely responsible for the run-down and abandoned farms in the older sections of the United States. For this element, most crops show a quicker response than for any other, and conversely, a falling off in yield will come sooner with a deficiency of nitrogen than of any other element. A supply of available nitrogen aids the plant in getting a good start so that its leaves may begin early to elaborate food from the air and its roots may reach out for the

water of the soil which holds in solution mineral plant-food.

Since nitrogen is supplied in many different forms, it at once becomes a question as to which of these is most efficient in crop production. Far too little attention has been given to this important question. Too often a certain material has been chosen because there was among farmers a general impression that this particular material was better than some other, when, as a matter of fact, there was no scientific basis for such conclusion. As an example, nitrogen from organic sources has been preferred by many because it was believed that organic matter thus supplied would be of great value in improving the physical condition of the soil, but in making this choice farmers overlooked the possibility of using a more readily-available material which would increase the crop residues sufficiently to more than make up for the small amount of organic matter contained in the few hundred pounds of dried blood, fish or tankage. Also, there is a widespread impression that the loss of nitrogen is greater when nitrates are used, than when organic nitrogen is used. But experiments both in this country and abroad show beyond a doubt that the crop yields and the percentage of nitrogen recovered in the crop were greater (and hence the loss must have been less) when nitrates were used than when organic sources of nitrogen were used.

The question of availability of nitrogenous fertilizers began to receive serious consideration at several of the leading European experiment stations some 30 years ago and much valuable information has been accumulated by these stations.

About 10 years later the subject began to receive attention in this country and it is a satisfaction to find that the results obtained here are fairly in accord with the findings of the European investigators.

Fairly complete reviews of this early work have been given in recent publications (2,3) and no attempt will be made here to cover this field.

The completion in 1917 of 20 years' work in which a

comparison is made of the materials mentioned in the title of this paper would seem to justify the publication at this time of a brief summary of the work. A detailed account covering the first 15 years of this work has already been published (3). Much of this need not be repeated, but the results of the last 5 years are of value as confirming the earlier work.

Experimental.

The work was originally outlined under the broad heading "Investigations Relative to the Use of Nitrogenous Materials," and this included: (a) a determination of the yield of dry matter and nitrogen in crops from soils receiving various treatments under controlled conditions; (b) the percentage of nitrogen in the crop as affected by the treatment; (c) the utilization of nitrogen in different materials; (d) the relative efficiency of nitrogen in different materials; (e) the residual effects of nitrogenous substances; (f) denitrification and (g) the effect of special treatment on the income and outgo of nitrogen in the soil.

As the work has progressed, more and more attention has been given to the utilization and relative efficiency of nitrogen in different materials, and it is this phase of the work which is to receive consideration in this paper.

In order that the work might be under more perfect control, it was carried out in galvanized iron cylinders, open at both ends and having a diameter of 23½ inches and a depth of 4 feet. These cylinders were set on the ground so that about 2 inches remained above the ground level. Thus the contents of the cylinders are isolated so that the roots of the crops growing in them are prevented from getting mineral plant-food from outside sources. The sub-soil is a gravelly sandy material such as occurs where the cylinders are located, but the top soil is a loam (Penn loam) brought from another source, an 8-inch layer of which was placed in each cylinder on top of the subsoil, each cylinder receiving the same weight of the thoroughly mixed soil.

When the work was begun all the soils were given a liberal treatment of lime in the form of ground limestone and with the exception of one series which does not enter into this discussion, all have received annual dressings of acid phosphate and potassium chloride at the rate of 640 pounds and 320 pounds per acre, respectively. Thus nitrogen is made the limiting factor insofar as human control can provide. Various combinations of manure and fertilizer were arranged, but it is sufficient to report here only on the four nitrogenous materials mentioned in the title.

One series received the phosphoric acid and potash, but no nitrogen, in order that it might be used as a check. Thus if a certain amount of nitrogen is recovered in the crop from the nitrogen-treated cylinder, and it is desired to calculate the percentage of the applied nitrogen that was recovered, it is necessary first to deduct from the total amount of nitrogen recovered in the crop, the amount recovered from the check cylinder, and thus account for the soil nitrogen that the crop used.

It is at once obvious that this cannot be an absolutely correct method of determining the percentage recovered, since in those cylinders to which nitrogenous fertilizers have been applied, the plant will make a quicker start and the roots go farther in search of the nitrogenous materials of the soil than in the check cylinders where there is a pronounced deficiency of available nitrogen, and thus the check fails to be a *true* check. In this way it happens that the recovery may *apparently* be more than 100 per cent. as shown in Series 8B, for the years 1901 and 1910. However, there appears to be no way of overcoming this error so long as the work is carried out in the natural soil and if one starts with an artificial soil, other and more serious difficulties arise.

In this work no effort has been made to analyze the roots, since it would be well-nigh impossible to do this correctly, and even if it could be done the same error would be introduced. The roots and stubble are left just as under field conditions so that the residual effects of these may be observed.

To draw conclusions from 1 to 2 years of such work would be manifestly unfair, but when it is carried on for a period of 10 or 20 years, seasonal differences, differences due to the unequal decomposition of organic matter and differences due to slight errors, which are sure to creep in now and then, are largely smoothed out and results are obtained which can be accepted with a fair degree of confidence. The confidence in such result is strengthened when it is found that they check with similar work conducted in other places or even in other countries.

The work was started in these cylinders in the spring of 1898 with corn as the first crop in the rotation. Four 5-year rotations have been carried out as follows:

First Rotation		Third Rotation	
1898	Corn	1908	Corn
1899	Oats (millet)	1909	Oats (corn)
1900	Oats (corn)	1910	Oats (corn)
1901	Wheat	1911	Rye and oats
1902	Timothy (two cuttings)	1912	Timothy (two cuttings)
Second Rotation		**Fourth Rotation**	
1903	Corn	1913	Corn
1904	Oats (corn)	1914	Oats (corn)
1905	Oats (corn)	1915	Oats (corn)
1906	Wheat	1916	Wheat
1907	Timothy (two cuttings)	1917	Timothy (two cuttings)

The corn following the oats is grown as a residual crop (without further addition of fertilizers) to utilize any nitrogen which the oat crop may have failed to get. All corn is planted thick and harvested as forage rather than as mature corn. Oats are harvested as oat-hay just before maturity, and wheat is harvested at maturity and saved as grain and straw.

Nitrogenous materials are applied for each main crop in the rotation as follows:

Cylinder 4B, farm manure, at the rate of 16 tons per acre.

Cylinder 8 B, nitrate of soda, at the rate of 320 pounds per acre.

Cylinder 17B, ammonium sulfate, equivalent to 320 pounds of nitrate of soda per acre.

Cylinder 18B, dried blood, equivalent to 320 pounds of nitrate of soda per acre.

Thus a careful record is kept of the amount of nitrogen applied each year and of the yield of dry matter from each cylinder. From determinations of the amount of nitrogen in the dry matter the total amount of nitrogen removed by the crop each year is easily calculated.

Yield of Dry Matter.

The yield of dry matter under the four different treatments for the 20 years is shown in table 1, averages being given for two 10-year periods and also for the entire 20 years. For each 10-year period the yield has been largest with the manure, though it is less for the second 10-year period than for the first, which would indicate that with manure at the rate of 16 tons per acre the fertility of the soil is not being fully maintained. The lowest yield is from 18B where dried blood is used as the source of nitrogen. Here again the average yield is less for the second 10-year period than for the first. For plots 8B and 17B, which receive nitrate of soda and ammonium sulfate, respectively, the average yields for the first 10 years are essentially the same for the two treatments, but for the second 10 years the average for the nitrate of soda treatment is considerably above that for the ammonium sulfate; furthermore, the average yield with ammonium sulfate is, like the yield with dried blood and farm manure, less for the second than for the first 10-year period. With the nitrate of soda, however, the figures are reversed, that is the average yield for the second 10 years is somewhat above that for the first 10 years.

The question may well be raised as to why the average yields on 4B, 17B and 18B should be less for the second 10-year period than for the first, while the yield on 8B has been well maintained for the 20 years. Since phosphoric acid and potash have been supplied each year in liberal amounts, and lime has been used at stated intervals, it would seem clear that the falling off in yield must be due to a deficiency of available nitrogen, notwithstanding the fact that cylinders 17B and 18B receive

each year just as much nitrogen as 8B, while 4B receives more than two and one-half times as much as 8B.

Data presented heretofore, and which are confirmed by results hereafter to be presented, show that of the four materials, nitrate of soda is most effective in crop production, that is, the crop is able to utilize or win back a larger percentage of nitrogen in this form than in any of the other forms. With a given amount of nitrogen, therefore, the crop yield can be better maintained over a period of years by the use of nitrogen in the form of nitrate of soda than in the other forms, provided the soil is one that does not allow rapid leaching.

TABLE 1

Yield of dry matter with different nitrogenous materials

FIRST 10-YEAR PERIOD						SECOND 10-YEAR PERIOD					
Year	Check*	4B	8B	17B	18B	Year	Check*	4B	8B	17B	18B
	gm.	*gm.*	*gm.*	*gm.*	*gm.*		*gm.*	*gm.*	*gm.*	*gm.*	*gm.*
1898......	291.1	467.1	393.9	401.0	341.8	1908....	169.0	326.0	331.0	286.0	228.0
1899......	146.6	354.1	184.5	190.5	186.3	1909....	164.0	208.0	244.0	217.0	218.0
1900......	238.1	387.2	317.0	310.1	307.9	1910....	214.0	422.0	338.0	287.0	276.0
1901......	126.0	342.2	331.0	300.0	239.4	1911....	68.0	236.0	160.0	117.0	126.0
1902......	86.2	147.8	150.9	143.9	115.6	1912....	88.0	221.0	187.0	153.0	115.0
1903......	160.3	315.0	183.0	291.0	216.0	1913....	177.2	390.5	312.5	228.5	286.5
1904......	118.7	262.0	170.0	167.0	160.0	1914....	137.0	285.8	222.4	196.9	198.3
1905......	125.7	262.0	226.0	209.0	191.0	1915....	103.7	231.2	211.0	178.3	147.5
1906......	98.3	316.0	244.0	226.0	144.0	1916....	91.4	250.9	217.3	181.6	112.9
1907......	107.3	237.0	168.0	133.0	172.0	1917....	71.1	229.0	208.0	167.0	139.0
Average†..	149.8	309.04	236.83	237.15	207.4	Average‡	128.3	280.04	243.12	201.23	184.72

* Phosphoric acid, potash and lime, no nitrogen.
† First ten years.
‡ Second ten years.

This apparently is what has happened in this case. With the gradual exhaustion of *soil* nitrogen, which was made available by the use of lime, and the failure of the ammonium sulfate, blood and manure to give back in the form of crops as large a proportion of the applied nitrogen as the nitrate of soda, the yields with the former became gradually less.

The fact that cylinder 4B gave the largest average yield through 20 years must not be taken as meaning that the treatment given this cylinder is necessarily the

best or most effective. It will be remembered that this cylinder receives cow manure at the rate of 16 tons per acre annually, the cost of which would be much in excess of the cost of 320 pounds of nitrate of soda or its equivalent in ammonium sulfate or dried blood, and therefore the larger yield does not necessarily mean an efficient use of the applied nitrogen. As a matter of fact, the work shows this to be the least efficient of the four forms.

Percentage of Nitrogen Recovered in the Crops.

Reference has already been made to the method of calculating the percentage of nitrogen that is recovered in the crop. The recoveries for the four different treatments covering the 20 years are shown in table 2. The averages for the period are as follows:

4B	32.69 per cent. (manure)
8B	62.42 per cent. (Nitrate of Soda)
17B	47.48 per cent. (ammonium sulfate)
18B	48.69 per cent. (dried blood)

This means that of 100 pounds of nitrogen applied in the four different forms approximately one-third, three-fifths, one-half, and two-fifths, respectively, are recovered or won back in the crop. As has already been mentioned, these figures agree quite closely with results reported from European countries, and they also confirm earlier work carried out at this Station.

But even so, they are not satisfying figures. We at once ask why there is this enormous loss of nitrogen and especially why the loss is so much greater with the organic materials than with the nitrate of soda and ammonium sulfate. If the loss is to be attributed to the leaching out of the materials, then it would seem that the figures should be reversed. Unquestionably, a certain amount of loss takes place in this way, but this cannot explain the loss of over two-thirds from the manure against a little more than one-third from nitrate.

It is well known that organic materials must undergo certain transformations in the soil before the nitrogen

can become available, and it seems that during these transformations nitrogen as ammonia, nitrate or as elemental nitrogen must be lost in considerable quantities. As bearing on this it may be pointed out that Russell and Richards (5) have shown by laboratory experiments with manure that in addition to the loss of ammonia by volatilization there is still a loss amounting to 15 per cent. or more of total nitrogen, and they have gone further and shown that during decomposition there is an evolution of gaseous nitrogen. This they believe completes the account of the loss. This loss, they claim, does not go on under wholly anaerobic or wholly aerobic conditions but under mixed anaerobic and aerobic conditions which arise when manure is being produced. They explain further that in the natural manure heap nitrogen is also lost as gaseous ammonia as well as in the form of nitrogen gas.

It is very probable that in a more limited way, similar changes take place when organic compounds are placed in the soil and that a part of the loss of nitrogen noted in our experiments must be thus accounted for. It is a well-known fact that when an organic substance like cottonseed meal or dried blood is mixed with soil and

TABLE 2

Percentage of nitrogen recovered from different materials

FIRST 10-YEAR PERIOD					SECOND 10-YEAR PERIOD				
Year	4B	8B	17B	18B	Year	4B	8B	17B	18B
1898........	28.15	63.75	66.06	58.18	1908.....	16.97	42.77	24.20	27.38
1899........	51.48	48.45	58.27	44.58	1909.....	18.25	80.64	54.94	49.04
1900........	36.18	77.55	69.47	57.25	1910.....	54.74	110.74	62.12	51.22
1901........	41.78	110.26	91.91	68.71	1911.....	20.98	64.10	48.46	41.59
1902........	11.48	32.06	23.64	14.32	1912.....	29.11	49.16	27.45	10.96
1903........	20.20	30.84	34.38	20.97	1913.....	27.63	32.92	15.50	40.26
1904........	38.91	46.19	39.26	33.68	1914.....	52.46	74.35	67.86	56.55
1905........	30.10	68.77	56.05	34.01	1915.....	32.13	64.10	52.53	48.12
1906........	44.94	81.81	30.80	24.78	1916.....	36.60	68.96	57.53	20.26
1907........	33.85	45.10	27.47	42.48	1917.....	27.95	55.77	41.75	29.41
Average*	33.71	60.48	49.73	39.90	Average†	31.68	64.35	45.23	37.48
Average‡	32.69	62.42	47.48	38.69					

* First ten years.
† Second ten years.
‡ Twenty years.

incubated in the laboratory for a few days, escaping ammonia may be detected, and from this it is a natural conclusion that when large quantities of organic matter are placed in the soil under natural conditions, some ammonia will be lost by volatilization, especially when the temperature and moisture conditions are favorable. This then, together with the evolution of gaseous nitrogen, would in part at least explain the heavy loss of nitrogen where manure was used at the rate of 16 tons per acre.

A discussion of this subject would not be completed without a brief reference to the effect of cultivation on nitrogen losses.

Shutt[2] for example has shown that when the prairie soils of Saskatchewan were left undisturbed the loss of nitrogen was slight, but as soon as cultivation was commenced losses set in.

Russell (4) refers further to losses of nitrogen as follows:

> One of the Broadbalk wheat plots receives annually 14 tons of farmyard manure per acre containing 200 pounds of Nitrogen. Only a little drainage can be detected and there is no reason to suppose that any considerable leaching out of Nitrates occurs, but the loss of Nitrogen is enormous amounting to nearly 70 per cent. of the added quantity.
>
> The condition for this decomposition appears to be copious aeration, such as is produced by cultivation and the presence of large quantities of easily decomposable organic matter. Now these are precisely the conditions of intensive farming in old countries and of pioneer farming in new lands, and the result is that the reserves of soil and manurial Nitrogen are everywhere being depleted at an appalling rate.

Russell refers to the recuperative actions that are going on, but says: "One of the most pressing problems at the present time is to learn how to suppress this gaseous decomposition and to direct the processes wholly into the nitrate channels."

In a paper on the nitrate content of cultivated and uncultivated soils, Blair and McLean (1), have called attention to the loss of nitrogen from cultivated soils and also to the low recovery from nitrogen applied as

[2] Cited by Russell (4).

organic materials. They point out that land under cultivation is gradually being depleted of its store of nitrogen even when nitrogenous fertilizers are applied each year and that the average recovery of nitrogen applied in the form of fish scrap for a period of nine years, was only 36.36 per cent.

With the same nitrogen treatment soils allowed to run wild just about maintained their nitrogen content, while the carbon content of these soils was slightly increased.

The recovery of nitrogen in the four different treatments for the 20 years is shown by the curves in figure 1. A study of these curves shows that the high points are generally reached in either the first or second year of oats, and in the wheat year, while the low points occur almost invariably in the corn and timothy years. It is not entirely clear whether this is a seasonal variation or a crop characterisic.

It is certain, however, that the utilization of the residual nitrogen by the corn crop which follows the oats, helps to explain the high recovery for the years when oats are grown.

Conclusions.

In a 5-year rotation on Penn loam soil well supplied with phosphoric acid, potash and lime, crop yields were better maintained over a period of 20 years with nitrate of soda at the rate of 320 pounds per acre than with an equivalent amount of ammonium sulfate or dried blood. For several years the latter gave results about on a par with the nitrate, but an average of the second 10-year period shows a considerable falling off with these materials as compared with the nitrate. This is no doubt due in part to the fact that the nitrate, being immediately available, gives the plant an early start which tends to keep it in the lead and to the further fact that in the transformation of the ammonium salt and the organic material into nitrates, there is a considerable loss of nitrogen, possibly as ammonia gas or gaseous nitrogen or both. The

loss cannot all be attributed to a leaching out of the materials, even though the nitrification of ammonia and organic residues may go on throughout a large portion of the year.

In the above-mentioned rotation cow manure at the rate of 16 tons per acre gave somewhat larger yields than nitrate of soda, but the increased yields were not sufficient to justify the increase in the cost of nitrogen.

Furthermore, the average yield with the manure was less for the second 10-year period than for the first, while the reverse is true with the nitrate of soda. Thus it is shown that with 16 tons of manure per acre annually, the crop yield is not being maintained, while with nitrate of soda at the rate of 320 pounds per acre annually it is increasing slightly, as shown by the average for the second 10-year period.

The percentage of nitrogen recovered in the crop was greater with the nitrate than with any of the other materials, the 20-year average being as follows:

	Per cent.
Nitrate of Soda	62.42
Ammonium sulfate	47.48
Dried blood	38.69
Cow manure	32.69

The average recovery with nitrate for the second 10-year period was 64.35 per cent. as against 60.48 per cent for the first 10-year period, whereas the average recovery with the ammonium sulfate, dried blood and manure was all less for the second 10-year period than for the first.

This is in agreement with the crop yields, and indicates a diminishing efficiency for the ammonium sulfate, blood and manure, and a gradual increase in efficiency for the nitrate of soda.

The work shows that when properly used nitrate of soda alone as a source of nitrogen may be depended upon to maintain crop yields over a long period, and that a given amount of nitrogen in this form is more effective than an equivalent amount in the form of ammonium sulfate, or organic materials.

Its effect is to produce larger crops per unit of nitrogen, and these crops, in turn, leave behind in the soil larger crop residues, and with carbonate of lime to aid in their decomposition these furnish a sufficient supply of organic matter to keep the soil in good physical condition.

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Cost of Transportation of Fertilizers.

A striking illustration of the difference in the cost of transportation by four different ways is given below:

To transport a ton by

Horse power, 5 miles;
Electric power, 25 miles;
Steam cars, 250 miles;
Steamships on the lakes, 1,000 miles;

costs the same amount in each case and the same amount of money will haul a ton

5 miles on a common road,
15 miles on a well-made stone road,
25 miles on a trolley road,
250 miles on a steam railway,
1,000 miles on a steamship.

It will be seen that the same amount of money it takes to haul a given amount of produce five miles on a public highway of the United States will pay the freight for 250 miles on a railroad and 1,000 miles on a steamship

line on the lakes. This is too great a difference, as will be admitted by all, and when we think of the fact that the railroad companies are ever at work repairing and improving their highways while the farmer is apparently so little awake to his own interests in regard to furnishing himself with better roads, we wonder why it is. The lesson seems plain and clear, and, as progressive farmers, let us continue to aid the good road movement throughout the country.

Nitrate of Soda is essentially a seaboard article; supplies at interior points are not always available, hence the ports of entry are as a rule the best sources of supply.

The improvement of our water-ways, so long urged by us, seems at last to be in sight; and farm chemicals at lower rates should ultimately be expected, even at interior points.

It has been the custom of the railroad companies to discriminate heavily and unfairly against Nitrate of Soda by charging almost prohibitory chemical rates, instead of equitable fertilizer rates, and it is hoped by correctly designating the material, the discrimination will not be practiced.

Farm newspapers, generally, are quite willing to publish wholesale quotations on all those things which the farmer has to sell, and they have not, as a rule, published wholesale quotations on those articles which he has to buy. Among the latter, agricultural chemicals occupy a position of prime importance, not only as to actual effect on farm prosperity, but as to the actual amount of cash which the farmer has to spend, for his produce comes out of the soil and its amount and quality is determined by the character of the chemicals he puts into it. Agricultural journals generally should make a continued effort in the direction of enhancing his purchasing power, by endeavoring to make him more prosperous.

OF GENERAL INTEREST.

Average Annual Rainfall in the United States.

Place	Inches	Place	Inches
Neah Bay, Wash	123	Hanover, New Hampshire	40
Sitka, Alaska	83	Ft. Vancouver	38
Ft. Haskins, Oregon	66	Cleveland, Ohio	37
Mt. Vernon, Alabama	66	Pittsburgh, Pennsylvania	37
Baton Rouge, Louisiana	60	Washington, D. C.	37
Meadow Valley, California	57	White Sulphur Springs, Va.	37
Ft. Towson, Oklahoma	57	Ft. Gibson, Oklahoma	36
Ft. Meyers, Florida	56	Key West, Florida	36
Washington, Arkansas	54	Peoria, Illinois	35
Huntsville, Alabama	54	Burlington, Vermont	34
Natchez, Mississippi	53	Buffalo, New York	33
New Orleans, Louisiana	51	Ft. Brown, Texas	33
Savannah, Georgia	48	Ft. Leavenworth, Kansas	31
Springdale, Kentucky	48	Detroit, Michigan	30
Fortress Monroe, Virginia	47	Milwaukee, Wisconsin	30
Memphis, Tennessee	45	Penn Yan, New York	28
Newark, New Jersey	44	Ft. Kearney	25
Boston, Massachusetts	44	Ft. Snelling, Minnesota	25
Brunswick, Maine	44	Salt Lake City, Utah	23
Cincinnati, Ohio	44	Mackinac, Michigan	23
New Haven, Connecticut	44	San Francisco, California	21
Philadelphia, Pennsylvania	44	Dallas, Oregon	21
New York City, N. Y.	43	Sacramento, California	21
Charleston, South Carolina	43	Ft. Massachusetts, Colorado	17
Gaston, North Carolina	43	Ft. Marcy, New Mexico	16
Richmond, Indiana	43	Ft. Randall, Dakota	16
Marietta, Ohio	43	Ft. Defiance, Arizona	14
St. Louis, Missouri	43	Ft. Craig, New Mexico	11
Muscatine, Iowa	42	San Diego, California	9
Baltimore, Maryland	41	Ft. Colville, Washington	9
New Bedford, Massachusetts	41	Ft. Bliss, Texas	9
Providence, Rhode Island	41	Ft. Bridger, Utah	6
Ft. Smith, Arkansas	40	Ft. Garland, Colorado	6

How Deep in the Ground to Plant Corn.

The following is the result of an experiment with Indian Corn. That which was planted at a depth of

1	inch, came up in	8½ days.
1½	inches, came up in	9½ days.
2	inches, came up in	10 days.
2½	inches, came up in	11½ days.
3	inches, came up in	12 days.
3½	inches, came up in	13 days.
4	inches, came up in	13½ days.

The more shallow the seed was covered with earth, the more rapidly the sprout made its appearance, and the stronger afterwards was the stalk. The deeper the seed lay, the longer it remained before it came to the surface: Four inches was too deep for the maize, and must, therefore, be too deep for smaller kernels.

Number of Years Seeds Retain Their Vitality.

Vegetables	Years	Vegetables	Years
Cucumber	8 to 10	Asparagus	2 to 3
Melon	8 to 10	Beans	2 to 3
Pumpkin	8 to 10	Carrots	2 to 3
Squash	8 to 10	Celery	2 to 3
Broccoli	5 to 6	Corn (on cob)	2 to 3
Cauliflower	5 to 6	Leek	2 to 3
Artichoke	5 to 6	Onion	2 to 3
Endive	5 to 6	Parsley	2 to 3
Pea	5 to 6	Parsnip	2 to 3
Radish	4 to 5	Pepper	2 to 3
Beets	3 to 4	Tomato	2 to 3
Cress	3 to 4	Egg-Plant	1 to 2
Lettuce	3 to 4		
Mustard	3 to 4	*Herbs.*	
Okra	3 to 4	Anise	3 to 4
Rhubarb	3 to 4	Caraway	2
Spinach	3 to 4	Summer Savory	1 to 2
Turnip	3 to 6	Sage	2 to 3

Amount of Barbed Wire Required for Fences.

Estimated number of pounds of Barbed Wire required to fence space for distances mentioned, with one, two or three lines of wire, based upon each pound of wire, measuring one rod (16½ feet).

	1 line	2 lines	3 lines
1 square acre	50⅔ lbs.	101⅓ lbs.	152 lbs.
1 side of a square acre.	12⅔ lbs.	25⅓ lbs.	38 lbs.
1 square half-acre	36 lbs.	72 lbs.	108 lbs.
1 square mile	1,280 lbs.	2,560 lbs.	3,840 lbs.
1 side of a square mile.	230 lbs.	460 lbs.	690 lbs.
1 rod in length	1 lb.	2 lbs.	3 lbs.
100 rods in length	100 lbs.	200 lbs.	300 lbs.
100 feet in length	6 1/16 lbs.	12⅛ lbs.	18 3/16 lbs.

How Grain will Shrink.

Farmers rarely gain by holding on to their grain after it is fit for market, when the shrinkage is taken into

account. Wheat, from the time it is threshed, will shrink two quarts to the bushel or six per cent. in six months, in the most favorable circumstances. Hence, it follows that ninety-four cents a bushel for wheat when first threshed in August, is as good, taking into account the shrinkage alone, as one dollar in the following February.

Corn shrinks much more from the time it is first husked. One hundred bushels of ears, as they come from the field in November, will be reduced to not far from eighty. So that forty cents a bushel for corn in the ear, as it comes from the field, is as good as fifty in March, shrinkage only being taken into account.

In the case of potatoes — taking those that rot and are otherwise lost — together with the shrinkage, there is but little doubt that between October and June, the loss to the owner who holds them is not less than thirty-three per cent.

This estimate is taken on the basis of interest at 7 per cent., and takes no account of loss by vermin.

One hundred pounds of Indian meal is equal to 76 pounds of wheat, 83 of oats, 90 of rye, 111 of barley, 333 of corn stalks.

Carrying Capacity of a Freight Car.

This Table is for Ten-Ton Cars.

Whiskey	60 barrels	Lumber	6,000 feet
Salt	70 barrels	Barley	300 bushels
Lime	70 barrels	Wheat	340 bushels
Flour	90 barrels	Flax Seed	360 bushels
Eggs..........130 to	160 barrels	Apples	370 bushels
Flour	200 sacks	Corn	400 bushels
Wood	6 cords	Potatoes	430 bushels
Cattle ....18 to	20 head	Oats	680 bushels
Hogs ....50 to	60 head	Bran	1,000 bushels
Sheep ....80 to	100 head	Butter	20,000 pounds

How to Measure Corn in Crib, Hay in Mow, etc.

This rule will apply to a crib of any size or kind. Two cubic feet of good, sound, dry corn in the ear will make a bushel of shelled corn. To get, then, the quantity of shelled corn in a crib of corn in the ear, measure the

length, breadth and height of the crib, inside of the rail; multiply the length by the breadth and the product by the height; then divide the product by two, and you have the number of bushels of shelled corn in the crib.

To find the number of bushels of apples, potatoes, etc., in a bin, multiply the length, breadth and thickness together, and this product by 8, and point off one figure in the product for decimals.

To find the amount of hay in a mow, allow 512 cubic feet for a ton, and it will come out very generally correct.

Length of Navigation of the Mississippi River.

The length of navigation of the Mississippi River itself for ordinary large steamboats is about 2,161 miles, but small steamers can ascend about 650 miles further. The following are its principal navigable tributaries, with the miles open to navigation:

	Miles		Miles
Minnesota	295	Wisconsin	160
Chippewa	90	Rock	64
Iowa	80	Illinois	350
Missouri	2,900	Yellowstone	474
Big Horn	50	Ohio	950
Allegheny	325	Monongahela	110
Muskingum	94	Kanawha	94
Kentucky	105	Green	200
Wabash	365	Cumberland	600
Tennessee	270	Clinch	50
Osage	302	St. Francis	180
White	779	Black	147
Little White	48	Arkansas	884
Big Hatchie	75	Issaquena	161
Sunflower	271	Yazoo	228
Tallahatchie	175	Big Black	35
Red	986	Cane	54
Cypress	44	Ouachita	384
Black	61	Boeuf	55
Bartholomew	100	Tensas	112
Macon	60	Teche	91
Atchafalaya	218	D'Arbonne	50
Lafourche	168		

The other ten navigable tributaries have less than fifty miles each of navigation. The total miles of navigation

of these fifty-five streams is about 16,500 miles, or about two-thirds the distance around the world. The Mississippi and its tributaries may be estimated to possess 15,550 miles navigable to steamboats, and 20,221 miles navigable to barges.

Business Rules for Farmers.

The way to get credit is to be punctual in paying your bills. The way to preserve it is not to use it much. Settle often; have short accounts.

Trust no man's appearances — they are deceptive — perhaps assumed, for the purpose of obtaining credit. Beware of gaudy exterior. Rogues usually dress well. The rich are plain men. Trust him, if any, who carries but little on his back. Never trust him who flies into a passion on being dunned; make him pay quickly, if there be any virtue in the law.

Be well satisfied before you give a credit that those to whom you give it are men to be trusted.

Sell your goods at a small advance, and never misrepresent them, for those whom you once deceive will beware of you the second time.

Deal uprightly with all men, and they will repose confidence in you, and soon become your permanent customers.

Beware of him who is an office seeker. Men do not usually want an office when they have anything to do. A man's affairs are rather low when he seeks office for support.

Trust no stranger. Your goods are better than doubtful charges. What is character worth, if you make it cheap by crediting everybody?

Agree beforehand with every man about to do a job, and, if large, put it into writing. If any decline this, quit, or be cheated. Though you want a job ever so much, make all sure at the outset, and in case at all doubtful, make sure of a guarantee. Be not afraid to ask it; the best test of responsibility; for, if offence be taken, you have escaped a loss.

Business Laws in Brief.

Ignorance of law excuses none.

It is a fraud to conceal a fraud.

The law compels no one to do impossibilities.

An agreement without consideration is void.

Signatures made with lead-pencil are good in law.

A receipt for money paid is not legally conclusive.

The acts of one partner bind all the others.

Contracts made on Sunday cannot be enforced.

A contract made with a minor is invalid.

A contract made with a lunatic is void.

Contracts for advertising in Sunday newspapers are invalid.

Each individual in a partnership is responsible for the whole amount of the debts of a firm.

Principals are responsible for the acts of their agents.

Agents are responsible to their principals for errors.

A note given by a minor is void.

It is not legally necessary to say on a note "for value received."

A note drawn on Sunday is void.

A note obtained by fraud, or from a person in a state of intoxication, cannot be collected.

If a note be lost or stolen, it does not release the maker; he must pay.

The indorser of a note is exempt from liability if not served with notice of its dishonor within twenty-four hours of its non-payment.

How to Treat Sunstroke.

Take the patient at once to a cool and shady place, but don't carry him far to a house or hospital. Loosen the clothes thoroughly about his neck and waist. Lay him down with the head a little raised. Apply wet cloths to the head, and mustard or turpentine to the calves of the legs and the soles of the feet. Give a little weak whiskey and water if he can swallow. Meanwhile, let some one go for the doctor. You cannot do more without his advice.

Sunstroke is a sudden prostration due to long exposure to great heat, especially when much fatigued or exhausted. It commonly happens from undue exposure to the sun's rays in summer. It begins with pain in the head, or dizziness, quickly followed by loss of consciousness and complete prostration.

How to Rent a Farm.

In the rental of property, the greater risk is always on the landlord's side. He is putting his property into the possession and care of another, and that other is not infrequently a person of doubtful utility. These rules and cautions may well be observed:

1. Trust to no verbal lease. Let it be in writing, signed and sealed. Its stipulations then become commands and can be enforced. Let it be signed in duplicate, so that each party may have an original.

2. Insert such covenants as to repairs, manner of use and in restraint of waste, as the circumstances call for. As to particular stipulations, examine leases drawn by those who have had long experience in renting farms, and adopt such as meet your case.

3. There should be covenants against assigning and underletting.

4. If the tenant is of doubtful responsibility, make the rent payable in installments. A covenant that the crops shall remain the lessor's till the lessee's contracts with him have been fulfilled, is valid against the lessee's creditors. In the ordinary case of renting farms on shares, the courts will treat the crops as the joint property of landlord and tenant, and thus protect the former's rights.

5. Every lease should contain stipulations for forfeiture and re-entry in case of non-payment or breach of any covenants.

6. To prevent a tenant's committing waste, the courts will grant an injunction.

7. Above all, be careful in selecting your tenant. There is more in the man than there is in the bond.

Facts for the Weatherwise.

If the full moon rises clear, expect fine weather.

A large ring around the moon and low clouds indicate rain in twenty-four hours; a small ring and high clouds, rain in several days.

The larger the halo about the moon the nearer the rain clouds, and the sooner the rain may be expected.

When the moon is darkest near the horizon, expect rain.

If the full moon rises pale, expect rain.

A red moon indicates wind.

If the moon is seen between the scud and broken cloud during a gale, it is expected to send away the bad weather.

In the old of the moon a cloudy morning bodes a fair afternoon.

If there be a general mist before sunrise near the full of the moon, the weather will be fine for some days.

Farmers' Barometers.

If the chickweed and scarlet pimpernel expand their tiny petals, rain need not be expected for a few hours, says a writer.

Bees work with redoubled energy before a rain.

If flies are unusually persistent either in the house or around the stock, there is rain in the air.

The cricket sings at the approach of cold weather.

Squirrels store a large supply of nuts, the husks of corn are usually thick, and the buds of deciduous trees have a firmer protecting coat if a severe winter is at hand.

Corn fodder is extremely sensitive to hygrometric changes. When dry and crisp, it indicates fair weather; when damp and limp, look out for rain.

A bee was never caught in a shower; therefore when his bees leave their hive in search of honey, the farmer knows that the weather is going to be good.

Philosophical Facts.

The greatest height at which visible clouds ever exist does not exceed ten miles.

Air is about eight hundred and fifteen times lighter than water.

The pressure of the atmosphere upon every square foot of the earth amounts to two thousand one hundred and sixty pounds. An ordinary sized man, supposing his surface to be fourteen square feet, sustains the enormous pressure of thirty thousand, two hundred and forty pounds.

The barometer falls one-tenth of an inch for every seventy-eight feet of elevation.

The violence of the expansion of water when freezing is sufficient to cleave a globe of copper of such thickness as to require a force of 27,000 pounds to produce the same effect.

During the conversion of ice into water one hundred and forty degrees of heat are absorbed.

Water, when converted into steam, increases in bulk eighteen hundred times.

In one second of time — in one beat of the pendulum of a clock — light travels two hundred thousand miles. Were a cannon ball shot toward the sun, and were it to maintain full speed, it woud be twenty years in reaching it — and yet light travels through this space in seven or eight minutes.

Strange as it may appear, a ball of a ton weight and another of the same material of an ounce weight, falling from any height will reach the ground at the same time.

The heat does not increase as we rise above the earth nearer to the sun but decreases rapidly until, beyond the regions of the atmosphere, in void, it is estimated that the cold is about seventy degrees below zero. The line of perpetual frost at the equator is 15,000 feet altitude; 13,000 feet between the tropics; and 9,000 to 4,000 between the latitudes of forty and forty-nine degrees.

At a depth of forty-five feet under ground, the temperature of the earth is uniform throughout the year.

In summer time, the season of ripening moves northward at the rate of about ten miles a day.

The human ear is so extremely sensitive that it can hear a sound that lasts only the twenty-four thousandth part of a second. Deaf persons have sometimes conversed together through rods of wood held between their teeth, or held to their throat or breast.

The ordinary pressure of the atmosphere on the surface of the earth is two thousand one hundred and sixty pounds to each square foot, or fifteen pounds to each square inch; equal to thirty perpendicular inches of mercury, or thirty-four and a half feet of water.

Sound travels at the rate of one thousand one hundred and forty-two feet per second — about thirteen miles in a minute. So that if we hear a clap of thunder half a minute after the flash, we may calculate that the discharge of electricity is six and a half miles off.

Lightning can be seen by reflection at the distance of two hundred miles.

The explosive force of closely confined gunpowder is six and a half tons to the square inch.

How to Preserve Eggs.

To each pailful of water, add two pints of fresh slaked lime and one pint of common salt; mix well. Fill your barrel half full with this fluid, put your eggs down in it any time after June, and they will keep two years, if desired. A solution of silicate of soda, commonly known as water glass, is also used for the same purpose.

Estimating Measures

A pint of water weighs nearly 1 pound, and is equal to about 27 cubic inches, or a square box 3 inches long, 3 inches wide and 3 inches deep.

A quart of water weighs nearly 2 pounds, and is equal to a square box of about 4 by 4 inches and 3½ inches deep.

A gallon of water weighs from 8 to 10 pounds, according to the size of the gallon, and is equal to a box 6 by 6 inches square and 6, 7 or 7½ inches deep.

A peck is equal to a box 8 by 8 inches square and 8 inches deep.

A bushel almost fills a box 12 by 12 inches square and 15 inches deep. In exact figures, a bushel contains 2150.42 cubic inches.

A cubic foot of water weighs nearly 64 pounds (more correctly 62½ pounds), and contains from 7 to 8 gallons, according to the kind of gallons used.

A barrel of water almost fills a box 2 by 2 feet square and 1½ feet deep, or 6 cubic feet.

Petroleum barrels contain 40 gallons, or nearly 5 cubic feet.

Square Measure

144 sq. inches = 1 sq. foot.	160 sq. rods = 1 acre.
9 sq. feet = 1 sq. yard.	43,560 sq. feet = 1 acre.
30¼ sq. yards = 1 sq. rod.	640 acres = 1 sq. mile.

2.47 acre = 1 hectare.

Facts for Builders.

One thousand shingles, laid 4 inches to the weather, will cover 100 square feet of surface, and 5 pounds of shingle nails will fasten them on.

One-fifth more siding and flooring is needed than the number of square feet of surface to be covered because of the lap in the siding and matching.

One thousand laths will cover 70 yards of surface, and 11 pounds of lath nails will nail them on. Eight bushels of good lime, 16 bushels of sand, and one bushel of hair, will make enough good mortar to plaster 100 square yards.

A cord of stone, 3 bushels of lime and a cubic yard of sand, will lay 100 cubic feet of wall.

Five courses of brick will lay one foot in height on a chimney; 16 bricks in a course will make a flue 4 inches wide and 12 inches long, and 8 bricks in a course will make a flue 8 inches wide and 16 inches long.

Cement 1 bushel and sand 2 bushels will cover 3½ square yards 1 inch thick, 4½ square yards ¾ inch thick, and 6¾ square yards ½ inch thick. One bushel cement and 1 of sand will cover 2½ square yards 1 inch thick, 3 square yards ¾ inch thick, and 4¼ square yards ½ inch thick.

Number of Brick Required to Construct Any Building.

(Reckoning 7 Brick to Each Superficial Foot)

Superficial Feet of Wall	Number of Bricks to Thickness of					
	4 inch	8 inch	12 inch	16 inch	20 inch	24 inch
1	7	15	23	30	38	45
2	15	30	45	60	75	90
3	23	45	68	90	113	135
4	30	60	90	120	150	180
5	38	75	113	150	188	225
6	45	90	135	180	225	270
7	53	105	158	210	263	315
8	60	120	180	240	300	360
9	68	135	203	270	338	405
10	75	150	225	300	375	450
20	150	300	450	600	750	900
30	225	450	675	900	1,125	1,350
40	300	600	900	1,200	1,500	1,800
50	375	750	1,125	1,500	1,875	2,250
60	450	900	1,350	1,800	2,250	2,700
70	525	1,050	1,575	2,100	2,625	3,150
80	600	1,200	1,800	2,400	3,000	3,600
90	675	1,350	2,025	2,700	3,375	4,050
100	750	1,500	2,250	3,000	3,750	4,500
200	1,500	3,000	4,500	6,000	7,500	9,000
300	2,250	4,500	6,750	9,000	11,250	13,500
400	3,000	6,000	9,000	12,000	15,000	18,000
500	3,750	7,500	11,250	15,000	18,750	22,500
600	4,500	9,000	13,500	18,000	22,500	27,000
700	5,250	10,500	15,750	21,000	26,250	31,500
800	6,000	12,000	18,000	24,000	30,000	36,000
900	6,750	13,500	20,250	27,000	33,750	40,500
1000	7,500	15,000	22,500	30,000	37,500	45,000

Weight of a Cubic Foot of Earth, Stone, Metal, Etc.

Article	Pounds	Article	Pounds
Alcohol	49	Milk	64
Ash wood	53	Maple	47
Bay wood	51	Mortar	110
Brass, gun metal	543	Mud	102
Blood	66	Marble, Vermont	165
Brick, common	102	Mahogany	66
Cork	15	Oak, Canadian	54
Cedar	35	Oak, live, seasoned	67
Copper, cast	547	Oak, white, dry	54
Clay	120	Oil, linseed	59
Coal, Lackawanna	50	Pine, yellow	34
Coal, Lehigh	56	Pine, white	34
Cider	64	Pine, red	37
Chestnut	38	Pine, well seasoned	30
Earth, loose	94	Silver	625¾
Glass, window	165	Steel, plates	487¾
Gold	1,203⅝	Steel, soft	489
Hickory, shell bark	43	Stone, common, about	158
Hay, bale	9	Sand, wet, about	128
Hay, pressed	25	Spruce	31
Honey	90	Tin	455
Iron, cast	450	Tar	63
Iron, plates	481	Vinegar	67
Iron, wrought bars	486	Water, salt	64
Ice	57½	Water, rain	62
Lignum Vitæ wood	83	Willow	36
Logwood	57	Zinc, cast	428
Lead, cast	709		

What a Deed to a Farm in Many States Includes.

Every one knows it conveys all the fences standing on the farm, but all might not think it also included the fencing-stuff, post rails, etc., which had once been used in the fence, but had been taken down and piled up for future use again in the same place. But new fencing material, just bought, and never attached to the soil, would not pass. So piles of hop poles stored away, if once used on the land and intended to be again so used, have been considered a part of it, but loose boards or scaffold poles merely laid across the beams of the barn, and never fastened to it, would not be, and the seller of the farm might take them away. Standing trees, of course, also pass as part of the land; so do trees blown down or cut down, and still left in the wood where they fell, but not if cut

and corded up for sale; the wood has then become personal property.

If there is any manure in the barnyard or in the compost heap on the field, ready for immediate use, the buyer ordinarily, in the absence of any contrary agreement, takes that also as belonging to the farm, though it might not be so, if the owner had previously sold it to some other party and had collected it together in a heap by itself, for such an act might be a technical severance from the soil, and so convert real into personal estate; and even a lessee of a farm could not take away the manure made on the place while he was in occupation. Growing crops also pass by the deed of a farm, unless they are expressly reserved; and when it is not intended to convey those, it should be so stated in the deed itself; a mere oral agreement to that effect would not be, in most states, valid in law. Another mode is to stipulate that possession is not to be given until some future day, in which case the crops or manures may be removed before that time.

As to the buildings on the farm, though generally mentioned in the deed, it is not absolutely necessary they should be. A deed of land ordinarily carries all the buildings on it, belonging to the grantor, whether mentioned or not; and this rule includes the lumber and timber of any old building which has been taken down, or blown down, and packed away for future use on farm.

Relative Value of Different Foods for Stock.

One hundred pounds of good hay for stock are equal to:

Articles	Pounds	Articles	Pounds
Beets, white silesia	669	Lucern	89
Turnips	469	Clover, Red, Dry	88
Rye-Straw	429	Buckwheat	78½
Clover, Red, Green	373	Corn	62½
Carrots	371	Oats	59
Mangolds	368½	Barley	58
Potatoes, kept in pit	350	Rye	53½
Oat-Straw	347	Wheat	44½
Potatoes	360	Oil-Cake, linseed	43
Carrot leaves (tops)	135	Peas, dry	37½
Hay, English	100	Beans	28

Hints for Farmers.

Vincent's Remedies for farm animals have been used with considerable success for several years, and they are recommended here as being worthy of trial.

First for Horses. When horses have chills, or have taken cold, or have colic, 15–20 drops of Aconite in a teacup of warm water will start perspiration, and if the horses are kept heavily blanketed, if the ailments are not more than ordinary, they will come out of them in good condition.

For Cattle. When cows get chilled, and if for any reason after dropping calves, the cows appear to shake, 15 drops of Aconite in a teacup of warm water will start perspiration, and if the cows are kept well blanketed, they will come out of the trouble without further treatment, unless the ailments are more than usual.

For Calves. A disease which has killed many fine young animals, even under the best conditions, is known as "scours." Vincent's cure in this case is a teaspoonful of Essence of Peppermint in half a teacup of warm water. This is to be administered after feeding night and morning, and is almost a certain cure, having saved the lives of many valuable calves.

For Sheep. A disease known as "stretches," caused by some stoppage in the bowels, can be frequently remedied by raising the sheep by its hind legs and holding it in that position for some minutes. In nine cases out of ten, a permanent cure is effected. This is worth remembering on account of many sheep having died from this cause.

To Revive Ferns.

Nitrate of Soda dissolved in water should be given to ferns that are small or weak, one-quarter of an ounce of Nitrate to a gallon of water. One-half an ounce of Nitrate to a gallon of water should be used on plants that are large and vigorous. Soot and salt are also good to use occasionally.

Capacity of Cisterns for Each 10 Inches in Depth.

25	feet in diameter holds	3,059 gallons
20	feet in diameter holds	1,958 gallons
15	feet in diameter holds	1,101 gallons
14	feet in diameter holds	959 gallons
13	feet in diameter holds	827 gallons
12	feet in diameter holds	705 gallons
11	feet in diameter holds	592 gallons
10	feet in diameter hlods	489 gallons
9	feet in diameter holds	396 gallons
8	feet in diameter holds	313 gallons
7	feet in diameter holds	239 gallons
6½	feet in diameter holds	206 gallons
6	feet in diameter holds	176 gallons
5	feet in diameter holds	122 gallons
4½	feet in diameter holds	99 gallons
4	feet in diameter holds	78 gallons
3	feet in diameter holds	44 gallons
2½	feet in diameter holds	30 gallons
2	feet in diameter holds	19 gallons

Surveyor's Measure.

7.92 inches 1 link, 25 links 1 rod, 4 rods 1 chain, 10 square chains or 160 square rods 1 acre, 640 acres 1 square mile.

Strength of Ice of Different Thickness.

Two inches thick — will support a man.

Four inches thick — will support a man on horseback.

Five inches thick — will support an eighty-pound cannon.

Eight inches thick — will support a battery of artillery, with carriages and horses.

Ten inches thick — will support an army; an innumerable multitude.

Amount of Oil in Seeds.

Kinds of Seed	Per Cent. Oil	Kinds of Seed	Per Cent Oil
Rapeseed	555	Oats	6½
Sweet almond	47	Clover hay	5
Turnipseed	45	Wheat bran	4
White mustard	37	Oat straw	4
Bitter almond	37	Meadow hay	3½
Hempseed	19	Wheat straw	3
Linseed	17	Wheat flour	3
Indian corn	7	Barley	2½

How to Kill Poison Ivy.

Spraying with arsenate of soda (one pound to twenty gallons of water) will kill all vegetation. One application, if the plants are young and tender, will do this. In the middle of the summer, however, they should be cut down first, and more than one application given.

To Find the Number of Plants to the Acre.

Divide the number of square feet in an acre, which is 43,560 by the multiplied distance the plants are set each way. For instance: Suppose the plants are set two feet apart and the rows are four feet apart. Four times two are eight; dividing 43,560 by eight we have 5,445, the number of plants to the acre when set 2 feet by 4 feet. If set 5 by 1, there are 8,712 plants to the acre, etc.

Savings Bank Compound Interest Table.

Showing the amount of $1.00, from one year to fifteen years, with compound interest added semi-annually, at different rates:

	Three Per Cent.	Four Per Cent	Five Per Cent
One year	$1 03	$1 04	$1 05
Two years	1 06	1 08	1 10
Three years	1 09	1 12	1 15
Four years	1 12	1 17	1 21
Five years	1 16	1 21	1 28
Six years	1 19	1 26	1 34
Seven years	1 23	1 31	1 41
Eight years	1 26	1 37	1 48
Nine years	1 30	1 42	1 55
Ten years	1 34	1 48	1 63
Eleven years	1 38	1 54	1 72
Twelve years	1 42	1 60	1 80
Thirteen years	1 47	1 67	1 90
Fourteen years	1 51	1 73	1 99
Fifteen years	1 56	1 80	2 09

Results of Saving Small Amounts of Money.

The following shows how easy it is to accumulate a fortune, provided proper steps are taken. The table shows what would be the result at the end of fifty years by saving a certain amount each day and putting it at interest at the rate of six per cent.:

Daily Savings	The Result	Daily Savings	The Resu
One cent	$950	Sixty cents	57,024
Ten cents	9,504	Seventy cents	66,528
Twenty cents	19,006	Eighty cents	76,032
Thirty cents	28,512	Ninety cents	85,537
Forty cents	38,015	One dollar	95,041
Fifty cents	47,520	Five dollars	465,208

Nearly every person wastes enough in twenty or thirty years, which, if saved and carefully invested, would make a family quite independent; but the principle of small savings has been lost sight of in the general desire to become wealthy.

Time at Which Money Doubles at Interest.

Rate	Simple Interest	Compound Interest
Two per cent	50 years	35 years, 1 day
Two and one-half per cent	40 years	28 years, 26 days
Three per cent	33 years, 4 months.	23 years, 164 days
Three and one-half per cent	28 years, 208 days.	20 years, 54 days
Four per cent	25 years	17 years, 246 days
Four and one-half per cent	22 years, 81 days.	15 years, 273 days
Five per cent	20 years	15 years, 75 days
Six per cent	16 years, 8 months.	11 years, 327 days

One dollar loaned one hundred years at compound interest at three per cent. would amount to $19.25, at six per cent. to $340.00.

Analyses of Commercial Fertilizing Materials.

NAME OF SUBSTANCE	Moisture	Nitrogen	Potash	PHOSPHORIC ACID		
				Available	Insoluble	Total
I. Phosphatic Manures —						
Apatite						36.08
Bone-ash	7.00					35.89
Bone-black	4.60					28.28
Bone-black (dissolved)				16.70	0.30	17.00
Bone meal	7.47	4.12		8.28	15.22	23.50
Bone meal (free from fats)		6.20				20.10
Bone meal (from glue factory)		1.70				29.90
Bone meal (dissolved)		2.60		13.53	4.07	17.60
S. Carolina rock (ground)	1.50			0.60	27.43	28.03
S. Carolina rock (floats)						27.20
S. Carolina rock (dissolved)				11.60	3.60	15.20
II. Potash Manures						
Carnallite			13.68			
Cotton-seed hull ashes	7.33		23.80			8.50
Kainit	3.20		13.54			
Krugite	4.82		8.42			
Muriate of potash	2.00		52.46			
Nitrate of potash	1.93	13.09	45.19			
Spent tan-bark ashes	6.31		2.04			1.61
Sulph. potash (high grade)	1.25		38.60			
Sulph. potash and magnesia	4.75		23.50			
Sylvinite	7.25		16.65			
Waste from gunpowder works	2.75	2.43	18.00			
Wood-ashes (unleached)	12.00		5.50			1.85
Wood-ashes (leached)			1.10			1.40
III. Nitrogenous Manures						
Castor pomace	9.98	5.56	1.12			2.16
Cotton-seed meal	6.80	6.66	1.62			1.45
Dried blood	12.50	10.52				1.91
Dried fish	12.75	7.25	0.45	0.35	5.20	8.25
Horn and hoof waste	10.17	13.25				1.83
Lobster shells	7.27	4.50				3.52
Meat scrap	12.09	10.44				2.07
Malt sprouts	7.40	4.04	2.20			1.70
Nitrate of soda	1.25	15.65				
Nitre-cake	6.00	2.30	0.40			
Oleomargarine refuse	8.54	12.12				0.88
Sulphate of ammonia	1.00	20.50				
Tankage	13.20	6.82		5.02	6.23	11.25
Tobacco stems	10.61	2.29	6.44			0.60
Wool waste	9.27	5.64	1.30			0.29
IV. Miscellaneous Materials.						
Ashes (anthracite coal)			0.10			0.10
Ashes (bituminous coal)			0.40			0.40
Ashes (corn-cob)			23.20			
Ashes (lime-kiln)	15.45		0.86			1.18

Analyses of Commercial Fertilizing Materials. *Continued.*

NAME OF SUBSTANCE	Moisture	Nitrogen	Potash	PHOSPHORIC ACID		
				Available	Insoluble	Total
IV. Miscellaneous Materials — Cont'd						
Ashes (peat and bog)	5.20	......	0.70	......	......	0.50
Gas lime	4.40	0.30	......	......	......	......
Marls (Maryland)	1.73	......	1.25	......	......	0.38
Marls (Massachusetts)	18.18	......	......	......	......	1.05
Marls (North Carolina)	1.50	......	0.04	......	......	0.56
Marls (Virginia)	15.98	......	0.49	......	......	0.09
Muck (fresh)	76.20	0.30	......	......	......	......
Muck (air-dry)	21.40	1.30	......	......	......	......
Mud (fresh water)	40.37	1.37	0.22	......	......	0.26
Mud (from sea-meadows)	53.50	0.20	0.20	......	......	0.10
Peat	61.50	0.75	......	......	......	......
Pine straw (dead leaves or pine needles)	7.80	0.30	0.10	......	......	0.20
Shells (mollusks)	......	0.10	0.04	......	......	0.03
Shells (crustacea)	......	6.20	0.20	......	......	2.30
Shell lime (oyster shell)	19.50	......	0.04	......	......	0.20
Soot	5.54	......	1.83	......	......	......
Spent tan	14.00	0.20	0.10	......	......	0.04
Spent sumach	30.80	1.00	0.30	......	......	0.10
Sugar-house scum	50.20	2.10	......	......	......	......
Turf	19.29	1.94	......	......	......	......

Analyses of Farm Manures.

TAKEN CHIEFLY FROM REPORTS OF THE NEW YORK, MASSACHUSETTS AND CONNECTICUT EXPERIMENT STATIONS.

NAME OF SUBSTANCE	Moisture	Nitrogen	Potash	Phosphoric acid
I.				
Cattle (solid fresh excrement)	....	0.29	0.10	0.17
Cattle (fresh urine)	....	0.58	0.49	....
Hen manure (fresh)	....	1.63	0.85	1.54
Horse (solid fresh excrement)	....	0.44	0.35	0.17
Horse (fresh urine)	....	1.55	1.50	....
Human excrement (solid)	77.20	1.00	0.25	1.09
Human urine	95.90	0.60	0.20	0.17
Poudrette (night soil)	....	0.80	0.30	1.40
Sheep (solid fresh excrement)	....	0.55	0.15	0.31
Sheep (fresh urine)	.....	1.95	2.26	0.01
Stable manure (mixed)	73.27	0.50	0.60	0.30
Swine (solid fresh excrement)	....	0.60	0.13	0.41
Swine (fresh urine)	....	0.43	0.83	0.07

Analyses of Fertilizing Materials in Farm Products.

ANALYSES OF HAY AND DRY COARSE FODDERS.

NAME OF SUBSTANCE	Moisture	Nitrogen	Potas h	Phosphoric acid
II. Hay and Dry Coarse Fodders				
Blue melilot	8.22	1.92	2.80	0.54
Buttercups	....	1.02	0.81	0.41
Carrot tops (dry)	9.76	3.13	4.88	0.61
Clover (alsike)	9.93	2.33	2.01	0.70
Clover (Bokhara)	6.36	1.77	1.67	0.44
Clover (mammoth red)	11.41	2.23	1.22	0.55
Clover (medium red)	10.72	2.09	2.20	0.44
Clover (white)	....	2.75	1.81	0.52
Corn fodder	....	1.80	0.76	0.51
Corn stover	28.24	1.12	1.32	0.30
Cow-pea vines	9.00	1.64	0.91	0.53
Daisy (white)	9.65	0.28	1.25	0.44
Daisy (ox-eye)	....	0.80	2.23	0.27
Hungarian grass	7 15	1.16	1.28	0.35
Italian rye-grass	8.29	1.15	0.99	0.55
June grass	....	1.05	1.46	0.37
Lucern (alfalfa)	6.26	2.07	1.46	0.53
Meadow fescue	9.79	0.94	2.01	0.34
Meadow foxtail	....	1.54	2.19	0.44
Mixed grasses	11.26	1.37	1.54	0.35
Orchard grass	8.84	1.31	1.88	0.41
Perennial rye-grass	9.13	1.23	1.55	0.56
Red-top	7.71	1.15	1.02	0.36
Rowen	12.48	1.75	1.97	0.46
Salt hay	5.36	1.18	0.72	0.25
Serradella	7.39	2.70	0.65	0.78
Soja bean	6.30	2.32	1.08	0.67
Tall meadow oat	....	1.16	1.72	0.32
Timothy hay	7.52	1.26	1.53	0.46
Vetch and oats	11.98	1.37	0.90	0.53
Yellow trefoil	....	2.14	0.98	0.43
III. Green Fodders.				
Buckwheat	82.60	0.51	0.43	0.11
Clover (red)	80.00	0.53	0.46	0.13
Clover (white)	81.00	0.56	0.24	0.20
Corn fodder	72.64	0.56	0.62	0.28
Corn fodder (ensilage)	71.60	0.36	0.33	0.14
Cow-pea vines	78.81	0.27	0.31	0.98
Horse bean	74.71	0.68	1.37	0.33
Lucern (alfalfa)	75.30	0.72	0.45	0.15
Meadow grass (in flower)	70.00	0.44	0.60	0.15
Millet	62.58	0.61	0.41	0.19
Oats (green)	83.36	0.49	0.38	0.13
Peas	81.50	0.50	0.56	0.18
Prickly comfrey	....	0.42	0.75	0.11
Rye grass	70.00	0.57	0.53	0.17
Serradella	82.59	0.41	0.42	0.14
Sorghum	....	0.40	0.32	0.08
Spanish moss	60.80	0.28	0.26	0.30
Vetch and oats	86.11	0.24	0.79	0.09
White lupin	85.35	0.44	1.73	0.35
Young grass	80.00	0.50	1.16	0.22

Analyses of Fertilizing Materials in Farm Products. *Cont'd*

NAME OF SUBSTANCE	Moisture	Nitrogen	Potash	Phosphoric acid
IV. Straw, Chaff, Leaves, etc.				
Barley chaff	13.08	1.01	0.99	0.27
Barley straw	13.25	0.72	1.16	0.15
Bean shells	18.50	1.48	1.38	0.55
Beech leaves (autumn)	15.00	0.80	0.30	0.24
Buckwheat straw	16.00	1.30	2.41	0.61
Cabbage leaves (air-dried)	14.60	0.24	1.71	0.75
Cabbage stalks (air-dried)	16.80	0.18	3.49	1.06
Carrots (stalks and leaves)	80.80	0.51	0.37	0.21
Corn cobs	12.09	0.50	0.60	0.06
Corn hulls	11.50	0.23	0.24	0.02
Hops	11.07	2.53	1.99	1.75
Oak leaves	15.00	0.80	0.15	0.34
Oat chaff	14.30	0.64	1.04	0.20
Oat straw	28.70	0.29	0.88	0.11
Pea shells	16.65	1.36	1.38	0.55
Pea straw (cut in bloom)	....	2.29	2.32	0.68
Pea straw (ripe)	....	1.04	1.01	0.35
Potato stalks and leaves	77.00	0.49	0.07	0.06
Rye straw	15.40	0.24	0.76	0.19
Sugar-beet stalks and leaves	92.65	0.35	0.16	0.07
Turnip stalks and leaves	89.80	0.30	0.24	0.13
Wheat chaff (spring)	14.80	0.91	0.42	0.25
Wheat chaff (winter)	10.56	1.01	0.14	0.19
Wheat straw (spring)	15.00	0.54	0.44	0.18
Wheat straw (winter)	10.36	0.82	0.32	0.11
V. Roots, Tubers, etc.				
Beets (red)	87.73	0.24	0.44	0.09
Beets (sugar)	84.65	0.25	0.29	0.08
Beets (yellow fodder)	90.60	0.19	0.46	0.09
Carrots	90.02	0.14	0.54	0.10
Mangolds	87.29	0.19	0.38	0.09
Potatoes	79.75	0.21	0.29	0.07
Ruta bagas	87.82	0.21	0.50	0.13
Turnips	87.20	0.22	0.41	0.12
VI. Grains and Seeds				
Barley	15.42	2.06	0.73	0.95
Beans	....	4.10	1.20	1.16
Buckwheat	14.10	1.44	0.21	0.44
Corn kernels	10.88	1.82	0.40	0.70
Corn kernels and cobs (cob meal)	10.00	1.46	0.44	0.60
Hemp seed	12.20	2.62	0.97	1.75
Linseed	11.80	3.20	1.04	1.30
Lupines	13.80	5.52	1.14	0.87
Millet	13.00	2.40	0.47	0.91
Oats	20.80	1.75	0.41	0.48
Peas	19.10	4.26	1.23	1.26
Rye	14.90	1.76	0.54	0.82
Soja beans	18.83	5.30	1.99	1.87
Sorghum	14.00	1.48	0.42	0.81
Wheat (spring)	14.75	2.36	0.61	0.89
Wheat (winter)	15.40	2.83	0.50	0.68

Analyses of Fertilizing Materials in Farm Products. *Cont'd*

NAME OF SUBSTANCE	Moisture	Nitrogen	Potash	Phosphoric acid
VII. Flour and Meal				
Corn meal	13.52	2.05	0.44	0.71
Ground barley	13.43	1.55	0.34	0.66
Hominy feed	8.93	1.63	0.49	0.98
Pea meal	8.85	3.08	0.99	0.82
Rye flour	14.20	1.68	0.65	0.85
Wheat flour	9.83	2.21	0.54	0.57
VIII. By-products and Refuse				
Apple pomace	80.50	0.23	0.13	0.02
Cotton hulls	10.63	0.75	1.08	0.18
Cotton-seed meal	....	6.52	1.89	2.78
Glucose refuse	8.10	2.62	0.15	0.29
Gluten meal	8.53	5.43	0.05	0.43
Hop refuse	8.98	0.98	0.11	0.20
Linseed cake (new process)	6.12	5.40	1.16	1.42
Linseed cake (old process)	7.79	6.02	1.16	1.65
Malt sprouts	10.28	3.67	1.60	1.40
Oat bran	8.19	2.25	0.66	1.11
Rye middlings	12.54	1.84	0.81	1.26
Spent brewers' grains (dry)	6.98	3.05	1.55	1.26
Spent brewers' grains (wet)	75.01	0.89	0.05	0.31
Wheat bran	11.01	2.88	1.62	2.87
Wheat middlings	9.18	2.63	0.63	0.95
IX. Dairy Products				
Milk	87.20	0.58	0.17	0.30
Cream	68.80	0.58	0.09	0.15
Skim-milk	90.20	0.58	0.19	0.34
Butter	13.60	0.12	....	....
Butter-milk	90.10	0.64	0.09	0.15
Cheese (from unskimmed milk)	38.00	4.05	0.29	0.80
Cheese (from half-skimmed milk)	39.80	4.75	0.29	0.80
Cheese (from skimmed milk)	46.00	5.45	0.20	0.80
X. Flesh of Farm Animals				
Beef	77.00	3.60	0.52	0.43
Calf (whole animal)	66.20	2.50	0.24	1.38
Ox	59.70	2.66	0.17	1.86
Pig	52.80	2.00	0.90	0.44
Sheep	59.10	2.24	0.15	1.23
XI. Garden Products				
Asparagus	....	0.32	0.12	0.09
Cabbage	....	0.30	0.43	0.11
Cucumbers	....	0.16	0.24	0.12
Lettuce	....	0.20	0.25	0.11
Onions	....	0.27	0.25	0.13

Table Showing the Number of Pounds of Nitrogen, Phosphoric Acid, and Potash Withdrawn Per Acre by an Average Crop.

(FROM NEW YORK, NEW JERSEY AND CONNECTICUT EXPERIMENT STATIONS' REPORTS.)

NAME OF CROP	Nitrogen	Phosphoric Acid	Potash
Barley	78	35	62
Buckwheat	63	40	17
Cabbage (white)	213	125	514
Cauliflower	202	76	265
Cattle turnips	187	74	426
Carrots	166	65	190
Clover, green (trifolium pratense)	171	46	154
Clover (trifolium pratense)	37	18	29
Clover, scarlet (trifolium incarnatum)	95	17	57
Clover (trifolium repens)	89	29	58
Cow pea	254	64	169
Corn	146	69	174
Corn fodder (green)	122	66	236
Cotton	110	32	35
Cucumbers	142	94	193
Esparsette	239	36	103
Hops	200	54	127
Hemp	....	34	54
Lettuce	41	17	72
Lucern	289	65	181
Lupine, green (for fodder)	219	46	63
Lupine, yellow (lupinus luteus)	80	37	155
Meadow hay	166	53	201
Oats	89	35	96
Onions	96	49	96
Peas (pisuni sativum)	153	39	69
Poppy	87	30	87
Potatoes	119	55	192
Rape	154	79	124
Rice	39	24	45
Rye	87	44	76
Seradella	128	57	196
Soja bean	297	62	87
Sugar cane	518	37	107
Sorghum (sorghum saccharatum)	446	90	561
Sugar beet (beet-root)	95	44	200
Tobacco	127	32	148
Vetch (visia sativa)	149	35	113
Wheat	111	45	58

Fertilizer Experiments on Meadow Land.

(KENTUCKY AGRICULTURAL EXPERIMENT STATION BULLETIN, No. 23, FEBRUARY, 1890.)

On low and decidedly wet land:

English Blue Grass.

Fertilizers used per Acre	Amount Per Acre in Pounds	Yield of Hay in Pounds Per Acre
Sulphate of potash................	160	3,000
Muriate of potash.................	160	2,950
Nitrate of Soda...................	160	3,100
Sulphate of ammonia..............	130	3,600
No fertilizer	...	2,850
Stable manure	20 loads	2,970
Tobacco stems	4,000	4,700

Fertilizer Experiments on Meadow Land.

Timothy

Kind of Fertilizer Used	Amount Per Acre in Pounds	Yield of Hay in Pounds Per Acre
Sulphate of potash................	160	1,900
Muriate of potash.................	160	2,320
Nitrate of Soda...................	160	2,670
Sulphate of ammonia..............	130	2,520
No fertilizer	...	1,620
Stable manure	20 loads	2,200
Tobacco stems	4,000	3,350

Time Required for the Complete Exhaustion of Available Fertilizing Materials and the Amounts of Each Remaining in the Soil During a Period of Seven Years.

(From Scottish Estimates.)

On Uncultivated Clay Loam.

Kind of Fertilizer Used	Exhausted (in years)	Per cent. remaining in soil unexhausted at the end of each year						
		1	2	3	4	5	6	7
Lime	12	80	65	55	45	35	25	20
Bone meal	5	60	30	20	10	00	00	00
Phosphatic guanos	5	50	30	20	10	00	00	00
Dissolved bones and plain superphosphates	4	20	10	5	00	00	00	00
High grade ammoniated fertilizers, guano, etc.........	3	30	20	00	00	00	00	00
Cotton-seed meal	5	40	30	20	10	00	00	00
Barnyard manure	5	60	30	20	10	00	00	00

On Uncultivated Light or Medium Soils.

Kind of Fertilizer Used	Exhausted (in years)	Per cent. remaining in soil unexhausted at the end of each year						
		1	2	3	4	5	6	7
Lime	10	75	60	40	30	20	15	..
Bone meal	4	60	30	10	00	00	00	..
Phosphatic guano	4	50	20	10	00	00	00	..
Dissolved bones and plain superphosphates	3	20	10	5	00	00	00	00
High grade ammoniates, guanos	3	30	20	00	00	00	00	00
Cotton-seed meal	4	40	30	20	10	00	00	00
Barnyard manure	4	60	30	10	00	00	00	00

On Uncultivated Pasture Land.

Kind of Fertilizer Used		Per cent. remaining in the soil unexhausted at the end of each year						
		1	2	3	4	5	6	7
Lime	15	80	70	60	50	45	40	35
Bone meal	7	60	50	40	30	20	10	00
Phosphatic guano	6	50	40	30	20	10	00	80
Dissolved bone, etc.	4	30	20	10	00	00	00	00
High grade ammoniated guanos	4	30	20	10	00	00	00	00
Cotton-seed meal	5	40	30	20	10	00	00	00
Barnyard manure	7	60	50	40	30	20	10	00

The figures given above are used in fixing the rental for new tenants. In this country no such careful estimates have been made.

Amounts of Nitrogen, Phosphoric Acid, and Potash Found Profitable for Different Crops Under Average Conditions Per Acre.

(*Taken Chiefly from New Jersey Experiment Stations Reports.*)

	Nitrogen, Pounds	Phosphoric Acid Pounds	Potash Pounds
Wheat, rye, oats, corn	16	40	30
Potatoes and root crops	20	25	40
Clover, beans, peas and other leguminous crops	..	40	60
Fruit trees and small fruits	25	40	75
General garden produce	30	40	60

Rotation in Crops.

In the changed conditions of agriculture elaborate systems of crop rotation are no longer necessary. With the help of chemical manures and the judicious use of renovating crops farmers are no longer subject to rigid

rule, but may adapt rotations to the varying demands of local market conditions.

Some American Rotations.

1. Potatoes.
2. Wheat.
3. Clover.
4. Clover.
5. Wheat, oats or rye.

1. Potatoes.
2. Wheat.
3. Grass, timothy and clover.
4. Grass, timothy and clover.
5. Corn.

1. Roots.
2. Wheat.
3. Clover.
4. Clover.
5. Corn, oats or rye.

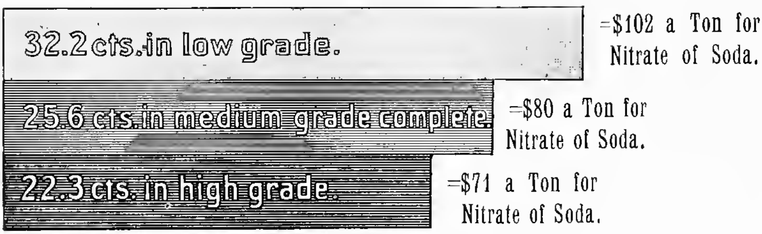
1. Roots.
2. Wheat.
3. Clover.
4. Clover.
5. Wheat.
6. Oats.

FERTILIZERS.

After the original Chart arranged by Director J. L. Hills, of the Vermont Experiment Station, for the U. S. Government Fertilizer Exhibit at the St. Louis Exposition.

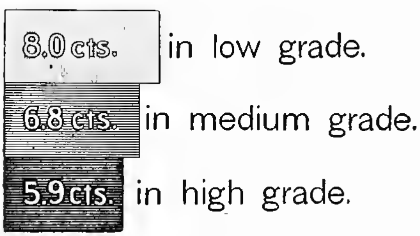
Average cost of a pound of plant food in "low," "medium" and "high" grade "complete fertilizers" (Vermont, 1903.)

The Nitrogen Cost per lb.



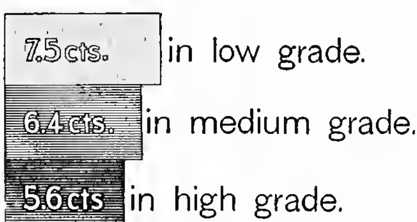
The Nitrogen in Nitrate of Soda, in 1903, cost 15 cents per lb.

The Available Phosphoric Acid Cost per lb.



The Phosphoric Acid in Acid Phosphate, in 1903, cost 4½ cents per lb.

The Actual Potash Cost per lb.



The Actual Potash in Sulphate of Potash, in 1903, cost 5 cents per lb.

Table of Quantities Required Per Acre

	Sow (if alone) per Acre
Agrostis stolonifera — See Creeping Bent	2 bushels
Agrostis canina — See R. I. Bent	3 bushels
Agrostis vulgaris — See Red Top	3 bushels
Agrostis vulgaris — Fancy	20 lbs.
Alopecurus pratensis — See Meadow Foxtail	3 to 4 bushels
Arrhenatherum avenaceum — See Tall Meadow Oat Grass	4 to 5 bushels
Avena elatior — See Tall Meadow Oat Grass	3 bushels
Arrhenatherum avenaceum — See Tall Meadow Oat Grass	4 to 5 busheds
Awnless Brome Grass	20 to 25 lbs.
Alsike or Hybrid Clover	8 lbs.
Alfalfa Clover	20 to 25 lbs.
Artichokes	8 to 10 bushels
Australian Salt Bush	2 lbs.
Barley	Broadcast, 2 to 2½ bushels; Drilled, 1½ to 2 bushels
Beet Sugar	6 to 8 lbs.
Bermuda Grass	6 lbs.
Bromus inermis — See Awnless Brome Grass	20 to 25 lbs.
Bokhara Clover	10 lbs.
Broom Corn	8 to 10 lbs.
Buckwheat	1 bushel
Bean, Field	Drilled, 1 bushel
Canada Blue Grass	3 bushels
Cynodon dactylon — See Bermuda Grass	6 lbs.
Creeping Bent or Fiorin	2 bushels
Crested Dog's Tail	1½ bushels
Cynosurus cristatus — See Crested Dog's Tail	1½ bushels
Cow Grass — See Mammoth Red Clover	10 to 12 lbs.
Crimson or Carnation — See Scarlet Clover	14 lbs.
Corn, Dent and Flint	8 to 10 qts.
Corn, Fodder	Broadcast, 2 bushels; Drilled, 1 bushel
Corn, Pop	6 to 8 qts.
Carrots	4 lbs.
Cotton	15 lbs.
Dactylis glomerata — See Orchard Grass	3 bushels
Douras	8 to 10 lbs.
English Blue Grass — See Meadow Fescue	2½ bushels
English or Perennial Rye Grass	2½ to 3 bushels
Festuca elatior — See Tall Meadow Fescue	2½ bushels
Festuca heterophylla — See Various Leaved Fescue	3 bushels
Festuca ovina — See Sheep's Fescue	2½ bushels
Festuca ovina tenuifolia — See Fine Leaved Sheep's Fescue	3 bushels
Festuca pratensis — See Meadow Fescue	2½ bushels
Festuca rubra — See Red Fescue	2½ bushels
Festuca duriuscula — See Hard Fescue	2½ bushels
Fine Leaved Sheep's Fescue	3 bushels
Flax Seed	½ to ¾ bushels
Fiorin — See Creeping Bent	2 bushels
Grasses, Permanent Pasture Mixtures	3 bushels
Grasses, Permanent Pasture Clover for above	10 lbs.
Grasses, Renovating Mixture	1 bushel
Grasses, Lawn	5 bushels
Herd's Grass (of the South) — See Red Top	3 bushels
Herd's Grass (of the North) — See Timothy	½ to 1 bushel
Hungarian Grass — See Hungarian Millet	1 bushel
Hard Fescue	2½ bushels
Italian Rye Grass	3 bushels
June Grass — See Kentucky Blue	2 to 3 bushels
June Clover — See Red Clover	10 to 12 lbs.
Japan Clover	14 lbs.
Johnson Grass	1 bushel
Jerusalem Corn	5 lbs.

	Sow (if alone) per Acre
Kaffir Corn	8 to 10 lbs.
Kentucky Blue Grass	3 bushels
Lupins	2 to 3 bushels
Lolium italicum — See Italian Rye Grass	3 bushels
Lolium perenne — See English Rye Grass	2½ to 3 bushels
Lucerne — See Alfalfa	20 to 25 lbs.
Lespedeza striata — See Japan Clover	14 lbs.
Meadow Foxtail	3 to 4 bushels
Meadow Fescue	2½ bushels
Mammoth or Pea Vine Clover	10 to 12 lbs.
Medicago sativa — See Alfalfa	20 lbs.
Millo Maize — See Douras	8 to 10 lbs.
Millet, German and Hungarian	1 bushel
Millet, Pearl, Egyptian, Cat-Tail or Horse Millet	Drills, 5 to 6 lbs; Broadcast, 8 lbs.
Millett, Japanese	Drills, 10 lbs. per acre; Broadcast, 15 lbs.
Mangels	6 to 8 lbs.
Melilotus alba — See Bokhara Clover	10 lbs.
Onobrychis sativa — See Sainfoin	3 to 4 bushels
Orchard Grass	3 bushels
Oats	3 bushels
Parsnip	6 lbs.
Poa nemoralis — See Wood Meadow Grass	2 bushels
Poa pratensis — See Kentucky Blue	2 to 3 bushels
Poa trivialis — See Rough Stalked Meadow Grass	1½ bushels
Poa arachnifera — See Texas Blue Grass	6 lbs.
Poa compressa	3 bushels
Phleum pratense — See Timothy	½ to 1 bushel
Potatoes	12 to 14 bushels
Peas, Field	3 bushels
Peas, Cow	2 bushels
Pea Vine Clover — See Mammoth Clover	10 to 12 lbs.
Perennial Red Clover — See Mammoth Clover	10 to 12 lbs.
Rape, English	2 to 4 lbs.
Red Top	3 bushels
Red Top, Fancy	20 lbs.
Rhode Island Bent	3 bushels
Red or Creeping Fescue	2½ bushels
Rough Stalked Meadow Grass	1½ bushels
Red Clover (Common or June Clover)	10 to 12 lbs.
Reana luxurians— See Teosinte	6 to 8 lbs.
Rye	1½ bushels
Ruta Baga	2 to 3 lbs.
Sorghum Halapense — See Johnson Grass	1 bushel
Sweet Vernal — true perennial	3½ bushels
Sheep's Fescue	2½ bushels
Smooth Stalked Meadow Grass — See Kentucky Blue	2 to 3 bushels
Sweet Clover — See Bokhara Clover	10 lbs.
Scarlet Clover	14 lbs.
Sainfoin	3 to 4 bushels
Sorghums	8 to 10 lbs.
Sugar Beet	6 to 8 lbs.
Sugar Canes	8 to 10 lbs.
Sunflower	4 qts.
Swedish Clover — See Alsike	8 lbs.
Soja Bean	¾ bushel
Texas Blue Grass	6 lbs
Tall Meadow Oat Grass	4 to 5 bushels
Tall Meadow Fescue	2½ bushels
Timothy or Herd's Grass of the North	½ to 1 bushel
Trifolium pratense — See Red Clover	10 to 12 lbs.
Trifolium pratense perenne — See Mammoth Clover	10 to 12 lbs.
Trifolium repens — See White Clover	8 lbs.
Trifolium incarnatum — See Scarlet Clover	14 lbs.
Trifolium hybridum — See Alsike Clover	8 lbs.
Teosinte	6 to 8 lbs.
Turnips	2 to 3 lbs.
Turnips, Ruta Baga, Russian or Swedish	2 to 3 lbs.

	Sow (if alone) per Acre
Vetch, Spring (Tares)	2 bushels
Vetch, Sand or Winter	1 bushel
Various Leaved Fescue	3 bushels
Wood Meadow Grass	2 bushels
White or Dutch Clover	8 lbs.
Wheat	1½ bushels

REFERENCE TABLE FOR VEGETABLE SEED SOWERS

KIND OF VEGETABLE	DATES FOR SOWING VICINITY, NEW YORK CITY. *North, later; South, earlier. As a general rule, it is pretty safe to allow six days' difference in planting for every hundred miles of latitude*		Best temperature to germinate	Days needed to germinate	Ready for use from seed sown	DISTANCE TABLE		Seed required for 100 feet of drill	Seed required for an acre
	Under glass	Open ground				Apart in rows	Rows apart		
Asparagus, seeds	....	April and May	60°	20 to 28	3 to 4 years	....	....	2 oz.	4 to 5 lbs.
" roots	....	April	....	....	....	1 ft.	2 ft.	....	....
Beans, dwarf	....	May 15th to Aug. 1st	75°	6 to 10	45 to 75 days	3 in.	2 ft.	1 qt.	1 bush.
" pole	....	May 15th to June 15th	80°	6 to 10	65 to 100 "	3 ft.	4 ft.	....	10 to 12 qts.
" lima	....	" "	80°	6 to 10	65 to 90 "	3 ft.	4 ft.	....	10 to 12 qts.
Beets	....	April to August	60°	7 to 10	60 to 75 "	4 in.	1 ft.	2 oz.	5 to 6 lbs.
Borecole (kale) for spring use	....	August and September	70°	6 to 10	85 to 120 "	2 ft.	2½ ft.	¾ oz.	1 to 2 lbs.
" " for fall use	....	June	70°	6 to 10	85 to 120 "	2 ft.	2½ ft.	¾ oz.	1 to 2 lbs.
Brussels sprouts	....	April to July	70°	6 to 10	100 to 120 "	1½ ft.	2½ ft.	....	1 lb.
Cabbage, early	February	April	70°	6 to 10	100 to 125 "	1½ ft.	2 ft.	....	½ lb.
" late	....	May and June	70°	6 to 10	120 to 180 "	2½ ft.	2½ ft.	....	½ lb.
Carrot, early	....	April	60°	10 to 15	65 to 85 "	4 iu.	1½ ft.	1 oz.	4 lbs.
" late	....	May to July	60°	10 to 15	100 to 120 "	5 in.	2 ft.	1 oz.	4 lbs.
Cauliflower, early	February	April	70°	6 to 10	100 to 115 "	1½ ft.	2½ ft.	....	½ lb.
" late	....	May and June	70°	6 to 10	100 to 135 "	2 ft.	3 ft.	....	½ lb.
Celery	....	April	60°	12 to 20	125 to 150 "	6 in.	3 to 5 ft.	1 oz.	1 lb.
Corn, sugar	....	May 10th to July 10th	75°	8 to 10	60 to 100 "	3 ft.	4 ft.	....	¼ bush.
Cucumber	....	May 15th to July 15th	80°	6 to 8	60 to 85 "	4 ft.	4 ft.	....	2 to 3 lbs.
Egg plant	March	....	80°	10 to 14	125 to 160 "	2½ ft.	2½ ft.	....	½ lb.
Endive	February	April to August	60°	6 to 10	75 to 100 "	1 ft.	1 ft.	1 oz.	3 lbs.
Kohl Rabi	....	April to July	70°	6 to 8	65 to 85 "	1 ft.	2 ft.	....	½ lb.
Leek	February	April and May	60°	6 to 10	120 to 160 "	6 in.	1½ ft.	1 oz.	5 to 6 lbs.
Lettuce	February	April to August	60°	6 to 10	75 to 100 "	1 ft.	1 ft.	1 oz.	2 to 3 lbs.
Melon, musk	....	May 15th to June 15th	80°	6 to 10	90 to 120 "	4 ft.	4 ft.	....	2 to 3 lbs.
" water	....	" "	80°	8 to 12	100 to 125 "	8 ft.	8 ft.	....	4 to 5 lbs.
Onion seed	February	April and May	60°	6 to 10	120 to 150 "	3 in.	1 ft.	1 oz.	5 to 6 lbs.
" sets	....	" "	....	....	....	3 in.	1 ft.	3 pts.	....
Parsley	....	" "	60°	18 to 24	90 to 100 "	4 in.	1 ft.	¾ oz.	5 to 6 lbs.
Parsnip	....	April	60°	12 to 18	100 to 150 "	6 in.	1 ft.	½ oz.	5 to 6 lbs.
Peas, wrinkled	....	April 15th to July 1st	70°	5 to 10	50 to 75 "	2 in.	2 to 4 ft.	1 qt.	2 to 3 bush.
" smooth	....	April 1st to Aug. 1st	65°	5 to 10	50 to 65 "	2 in.	2 to 4 ft.	1 qt.	2 to 3 bush.
Pepper	March	....	80°	10 to 14	135 to 150 "	2 ft.	2½ ft.	....	½ lb.
Potatoes	....	April 15th to June 1st	70°	15 to 25	75 to 100 "	10 in.	2½ ft.	....	10 to 12 bush.
Pumpkins	....	May 20th to June 20th	80°	6 to 10	100 to 125 "	8 ft.	8 ft.	....	4 to 5 lbs.
Radish	....	April 1st to Sept. 15th	60°	4 to 6	25 to 50 "	2 to 4 in.	1 to 1½ ft.	1 oz.	9 to 10 lbs.
Salsify	....	April and May	60°	8 to 12	125 to 160 "	6 in.	1½ ft.	1½ oz.	8 to 10 lbs.
Spinach	....	April to Sept. 15th	60°	6 to 12	60 to 75 "	4 in.	1 to 1½ ft.	1 oz.	10 to 12 lbs.
Squash, summer	....	May 15th to July 1st	80°	6 to 10	60 to 75 "	4 ft.	4 ft.	....	3 to 4 lbs.
" winter	....	May 20th to June 20th	80°	6 to 10	100 to 125 "	8 ft.	8 ft.	....	3 to 4 lbs.
Tomato	Feb. and Mar.	June 1st	80°	6 to 10	125 to 150 "	3 ft.	3 ft.	....	½ lb.
Turnip	....	April to September	70°	4 to 7	60 to 75 "	6 in.	1 to 1½ ft.	¾ oz.	1 to 2 lbs.

INDEX